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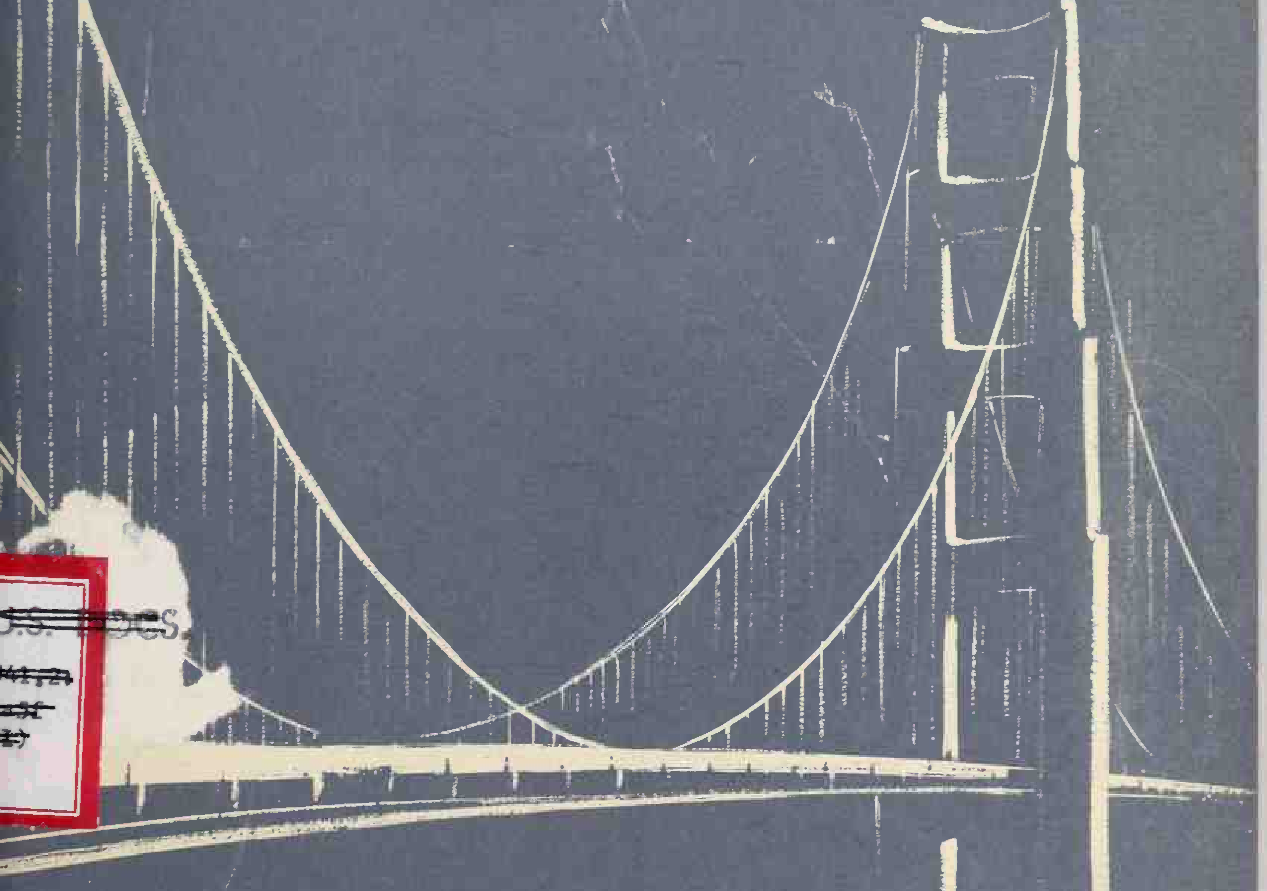
ECONOMIC ASPECTS OF COMPREHENSIVE SURVEY
OF SAN FRANCISCO BAY AND TRIBUTARIES

Future Development of the San Francisco Bay Area 1960–2020



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Prepared for U.S. Army Corps of Engineers by
U.S. DEPARTMENT OF COMMERCE

U.S. Dept. of Commerce. Office of Area Development.

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DECEMBER 1959

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WASHINGTON 25, D.C.

OFFICE OF AREA DEVELOPMENT

Letter of Transmittal

DECEMBER 1, 1959.

Col. JOHN S. HARNETT,
District Engineer, U.S. Army Engineer District, San Francisco,
Corps of Engineers
San Francisco, Calif.

DEAR COLONEL HARNETT: The Office of Area Development has prepared two reports for the U.S. Army Corps of Engineers on the future development of the San Francisco Bay Area. "Economic Aspects of Survey for the Comprehensive Development of San Francisco Bay Area and Tributaries, Part I: Evaluation of Existing Population Projections," October 1957, reviewed previous population projections for the Bay Area and recommended certain projections for interim use until projections based on more recent data could be prepared. This interim report was not reproduced for general distribution, but a summary is included in Appendix B of the present report. This second report containing such projections, transmitted herewith, is entitled "Future Development of the San Francisco Bay Area: 1960–2020."

This report provides population projections for each decade from 1960 to 2020 for the Bay Area as a whole and for the nine counties of the Bay Area and their townships (including maps showing the distribution of these populations). It also includes an appraisal of the future economy of the Bay Area with estimates of future employment in the major economic activities, projected distribution of various land uses (mapped by decades), and a study of land reclamation possibilities.

Estimates contained in this report are presented in detailed form. As such, these estimates permit periodic updating when additional information indicates the desirability of review.

Sincerely yours,

Victor Roterus

VICTOR ROTERUS,
Director.

132449

Foreword

(By The District Engineer, U.S. Army Engineer District, San Francisco)

This report provides some of the information required in several of the elements of study in the "Comprehensive Survey of San Francisco Bay and Tributaries, California." Corollary considerations will be contained in the Corps of Engineers' survey report to be completed at a later date.

The Corps of Engineers has not completed its review of these projections and procedures and, at the time of this printing, does not endorse the projections. The final basis for evaluation of improvements under consideration by the Corps of Engineers will be determined after official review.

Because of its independent usefulness to civic, governmental and business groups in the San Francisco Bay Area, this report by the Office of Area Development has been made available in advance of completion of the comprehensive survey report.

John S Harnett

John S. Harnett,
Colonel, Corps of Engineers,
District Engineer.

Acknowledgments

This report on the future development of the San Francisco Bay Area was prepared under the general direction of Victor Roterus, Director, and the specific direction of Gustav E. Larson, Deputy Director, Office of Area Development.

J. Slaten Jenner and Dr. Louis C. Peltier were responsible for early stages of project planning and field research.

Major study sections of this report were prepared by personnel of the Office of Area Development as follows:

Chapter II, Population Growth and Distribution, Gustav E. Larson, Dr. Roger A. Prior, and Dr. Louis C. Peltier; Area Density Method of population projection and distribution developed by Dr. Louis C. Peltier and Albert E. Craig.

Chapter III, Employment and Economic Growth, Dr. Roger A. Prior.

Chapter IV, Land for Urban Needs, Gordon E. Reckord.

Chapter V, Reclamation of Marsh, Tide, and Submerged Lands; and Reclamation Bibliography, Dr. William Van Royen, consultant, University of Maryland, and Curtis O. Siegel.

Important contributions made by other personnel of the Office of Area Development include:

Economic research and analysis by David Brown for chapter III.

Compilation of land-use data, measurements of potential urban land, and preparation of land-use maps by Charles F. Daoust for chapter IV.

Review and analysis of material on reclamation by Theodore K. Pasma and Frederick H. Eaton for chapter V.

Supervision of drafting of population-distribution maps and other graphics by Dr. William Van Royen.

Preparation of land-use statistics from land-use maps by J. Richard Fernstrom.

Assistance in preparation of statistical tables and graphics by Edward Yurchak.

Richard E. Cozzens, U.S. Coast and Geodetic Survey, supervised drafting of the land-use maps. Dr. Arthur Karinen did preliminary work on the population maps. Joseph W. Wiedel of the University of Maryland, consultant to the Office of Area Development, drafted the population maps and other illustrations and made the final editorial corrections and revisions on all graphic materials.

Among the many Federal personnel and agencies who assisted on various phases of this report were:

John Judge, Manager, and Merrill Woodruff of the San Francisco Field Office, U.S. Department of Commerce.

Jacob S. Siegel and Meyer Zitter, Population Division, Bureau of the Census, who prepared special population projections for the report.

Directors and staff members of the industry divisions of the Business and Defense Services Administration, U.S. Department of Commerce; the Office of Business Economics, U.S. Department of Commerce; the Bureau of Foreign Commerce, U.S. Department of Commerce; the Foreign Trade Division of the Bureau of the Census, U.S. Department of Commerce; the Bureau of Yards and Docks, U.S. Department of the Navy; and the Fish and Wildlife Service, U.S. Department of the Interior.

Personnel of California State government agencies who contributed information and suggestions to the project included Herbert A. Howlett, Herbert W. Greydanus, Department of Water Resources; Carl Frisen, Department of Finance; George S. Roche, Department of Employment; Ronald B. Welch, State Board of Equalization; J. P. Sinclair and B. W. Booker, Department of Public Works; Maurice I. Gershenson, Department of Industrial Relations; Stuart Adams, Department of Corrections; and R. A. Hayler, District Engineer, Division of Highways, State of California.

Help and cooperation in making available studies and information on land use, industry, economic trends, foreign trade, and other subjects pertinent to this project were provided by the San Francisco Bay Area Council, the California State Chamber of Commerce, the San Francisco World Trade Center, the Bank of America, the Pacific Gas & Electric Co., the Pacific Telephone & Telegraph Co., the consulting firm of Parsons, Brinckerhoff, Hall & Macdonald, and other independent consulting firms, and city and county planning agencies throughout the San Francisco Bay Area.

Persons due appreciative thanks for their cooperation include: Leslie I. Hood and Frank E. Marsh of the San Francisco Bay Area Council; Paul Opperman and Bryant Hall of the San Francisco County Planning Commission; Karl Belser of the Santa Clara County Planning Commission; Robert Williams of the Alameda County Planning Commission; Frank Stratton and Sheldon Glatt of the Western Pacific Railroad; Melvin Webber and David Weeks of the University of California; Roger Mendes of the Pacific Gas & Electric Co.; William H. Gilmartin of the Pacific Telephone & Telegraph Co.; Henry Evans of Wilbur Smith & Associates; C. D. Lafferty and David E. Porter of the Southern

Pacific Railroad; Harry Moses of consulting firm Parsons, Brinckerhoff, Hall & Macdonald; Frank Feliz of the San Francisco World Trade Center; and representatives of the Crown-Zellerbach Corp., the Lockheed Aircraft Corp., Safeway Stores, and the Standard Oil Co. of California.

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Thanks also are due R. J. Johnson, H. G. Dewey, Jr., W. J. Homan, J. A. Stirton, A. C. Dunlop, J. L. Maxwell, and J. A. Finck of the Corps of Engineers, U.S. Army, San Francisco, for their cooperation and constructive suggestions throughout the period of study.

Agnes M. Updegraff, Office of Area Development, supervised typing of the manuscript report.

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Introduction

1. Authority and Purpose

Congressional authority for the "Comprehensive Survey of San Francisco Bay and Tributaries, California" was established by the River and Harbor Act, section 110 (Public Law 516, 81st Cong., 2d sess.), approved May 17, 1950. The Chief of Engineers, Washington, D.C., through the South Pacific Division Engineer, assigned the preparation of the report to the San Francisco District Engineer.

This survey will constitute a comprehensive, factual appraisal of various plans by which the San Francisco Bay Area may realize optimum use of its resources. Elements of the study cover such varied topics as water supply (involving salt-water barriers), navigation, flood control, Bay crossings for land transport, reclamation, recreation, and national defense.

An orientation map of the San Francisco Bay Area, including place names and current and proposed freeway systems, is contained in the plate supplement prepared for this report. (See pl. 1.)

2. Studies Assigned to and Prepared by Office of Area Development

The Corps of Engineers requested Federal and State agencies to undertake various sections of the survey. Subsequently, the Office of Area Development agreed, on a reimbursable basis, to undertake two sections. The first part of the assignment called for a review and evaluation of existing population projections for the San Francisco Bay Area. This review was made by the Office of Area Development, and a report was submitted to the Corps of Engineers in October 1957. That report is entitled "Economic Aspects of Survey for the Comprehensive Development of San Francisco Bay and Tributaries, Part I: Evaluation of Existing Population Projections." (For a summary of this review report, see pp. B–1—B–3, app. B.)

The second part of the work assigned to the Office of Area Development included preparation of independent population projections to the year 2020; a land-use study, including maps, showing estimated uses of land by major categories of land use, by decades, to 2020; a supporting study of industrial development, analyzing potentials for future development; a review of past land reclamation, with a view toward future potentialities and needs for reclaimed land; and a study of the waterborne trade aspects of future Bay Area development, including an analysis of future prospects for foreign and domestic waterborne trade and the effect of such trade on the economy of the Bay Area. The above studies were completed as a second part of the project and, with the exception of the waterborne trade study, are included as a part of this report, "Future Development of the San Francisco Bay Area: 1960–2020." The waterborne trade study will be included in a navigation appendix to the Corps of Engineers' final survey report.

3. *Area and Scope*

This report is designed to show, on a decade-to-decade basis, how the San Francisco Bay Area could grow from 1960 to 2020. The study area includes the counties of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma. The report provides (1) population projections, by decades from 1960 to 2020, for the San Francisco Bay Area, including population projections for townships and counties; (2) projections of future employment by major employment categories for the San Francisco Bay Area, for each decade from 1960 to 2020; (3) projection of probable future land-use patterns, by decades from 1960 to 2020; and (4) estimates of land susceptible of reclamation, including an appraisal of the possibilities of such reclamation.

Included also are such basic studies and materials as a national sample survey of plans of industry and business for expanding employment in the Bay Area; a reclamation bibliography covering reclamation activity in countries throughout the world; population-distribution and land-use maps for each decade from 1960 to 2020; and such other technical support papers and analyses as were required.

4. *Method and Procedure*

Method and procedure followed in preparing this report are described in the various chapters and appendixes. Chapter II, Population Growth and Distribution, provides step-by-step details on how the population projections were derived and how they are related to and supported by other studies and analyses in the report.

In general, the study approach to this report involved (1) determination of the future limits of national population and economic growth; (2) estimation of the share of such future national growth that the San Francisco Bay Area could reasonably be expected to obtain; (3) projection and distribution of population by minor civil divisions in the Bay Area; and (4) check of these estimates and projections derived in (2) and (3) against estimates of probable future economic growth, against historical population and density-growth experiences of both the Bay Area and of other more mature cities in the United States, and finally, against amount and type of available land.

Several projections—population, economic, land use—were made before a decision was made on the final population projections to be used. A close relationship between the results of various projections, derived from several different bases, was indicated by the comparison and analysis which appear on page 16, chapter II, and pages A–4—A–6, appendix A.

5. *Limitations of Projections and Need for Review*

Estimates of future population and economic growth obtained by projecting population and economic activity must be considered solely as generalized guides to the future. Anyone projecting national economic activity 50 years ago, for example, could not have foreseen the development of the automobile industry (presently the largest), the aircraft industry (next largest), or the growth of the electronics and missiles industries. It is highly probable that, in the future, some industries will disappear and that entirely new ones will be established.

Because economic, population, and land-use projections can be only general approximations of future development, and because such projections become less reliable for later decades, this report should be interpreted as a general guide to the future, and its projections should be seen as subject to change with the passage of time and in the light of new experience. Material used in preparing this report was no later in date than August 1959. It will be necessary to review these projections as new information on economic and population trends becomes available and to make such modifications in them as may be indicated.

Chapter I. Summary

This report describes how, under specified conditions, the San Francisco Bay Area will grow and develop from 1960 to 2020. The study covers a 60-year period to meet the needs of the Corps of Engineers in analyzing projects for the future on a long-range basis. The study area (hereafter referred to as the San Francisco Bay Area) comprises the counties of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma. (See orientation map, plate supplement, plate 1.)

Major findings of this report are that the San Francisco Bay Area in 2020 will have a population of 14.4 million, of which more than 5 million people will be employed, and that there is sufficient potential urban land (3,600 square miles) to accommodate the urban land requirements (2,400 square miles) of the projected population and economy. In addition to these major findings, the report provides detailed estimates of the future population, economy, and land use on a decade-to-decade basis, and indicates what the population distribution and land-use patterns in the Bay Area are likely to be on a minor civil division basis.

Illustrative materials supporting this study are contained in the plate supplement. Included in the plate supplement are orientation map (pl. 1); growth lines map, 1950–2010 (pl. 2); population distribution maps for each decade from 1960 to 2020 (pls. 3–9); a map showing land suitable for urban use (pl. 10); land-use maps for 1958 and each decade from 1960 to 2020 (pls. 11–18); a map showing historical development of reclaimed land, 1850–1958 (pl. 19); a map showing present use of reclaimed land, 1958 (pl. 20); and a map showing areas susceptible of reclamation in San Francisco Bay Area (pl. 21).

The report, in addition to presenting recommended population projections (see table 1, and table 5 in ch. II) and population density projections (see table 6, ch. II) for the decades from 1960 to 2020, includes adjusted population projections (see table 7, ch. II). The recommended population projections, used hereafter as the basis for all discussion and illustrations in the report, reflect an assumption that there will be two periods of slower economic growth which are expected to result from future cyclical movements of the economy. The adjusted population projections are provided for planners who prefer to use for planning purposes projections which have been adjusted by spreading out the two periods of assumed slower economic growth over the entire projection period. (See page 22.)

> NOTE.—All discussion, tables, figures, and maps are based on the recommended population projections shown in table 5, chapter II. The adjusted population projections are not used as the basis for analysis or illustration in this report but are presented only for the convenience of those who wish to use adjusted rather than recommended projections.

Some of the key findings of the report are summarized in this chapter in the following four parts: Outlook for Population Growth, Outlook for Employment Growth, Outlook for Land Use, and Outlook for Land Reclamation.

6. *Outlook for Population Growth*

(*a*) *San Francisco Bay Area population of 14.4 million expected in 2020.*—The population of the San Francisco Bay Area (see table 1, fig. 1, and pls. 3, 6, and 9, plate supplement) is projected to grow from an estimated 3.8 million in 1960 to 7.4 million in 1990, reaching 14.4 million by 2020. In 1960, 2.4 million people are expected to be living in the South Bay counties (excluding San Francisco County), and somewhat more than 0.5 million in the North Bay counties. By 2020, nearly 10 million people will live in the South Bay, while North Bay counties will have a population of nearly 4 million.

Here, and elsewhere [1] in this report where population is the subject, San Francisco County has been excluded from the South Bay in order to highlight the areas expected to experience the greatest changes in population.

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[1] In table 9, ch. II, San Francisco County is included in the South Bay solely for the purpose of ranking all the counties.

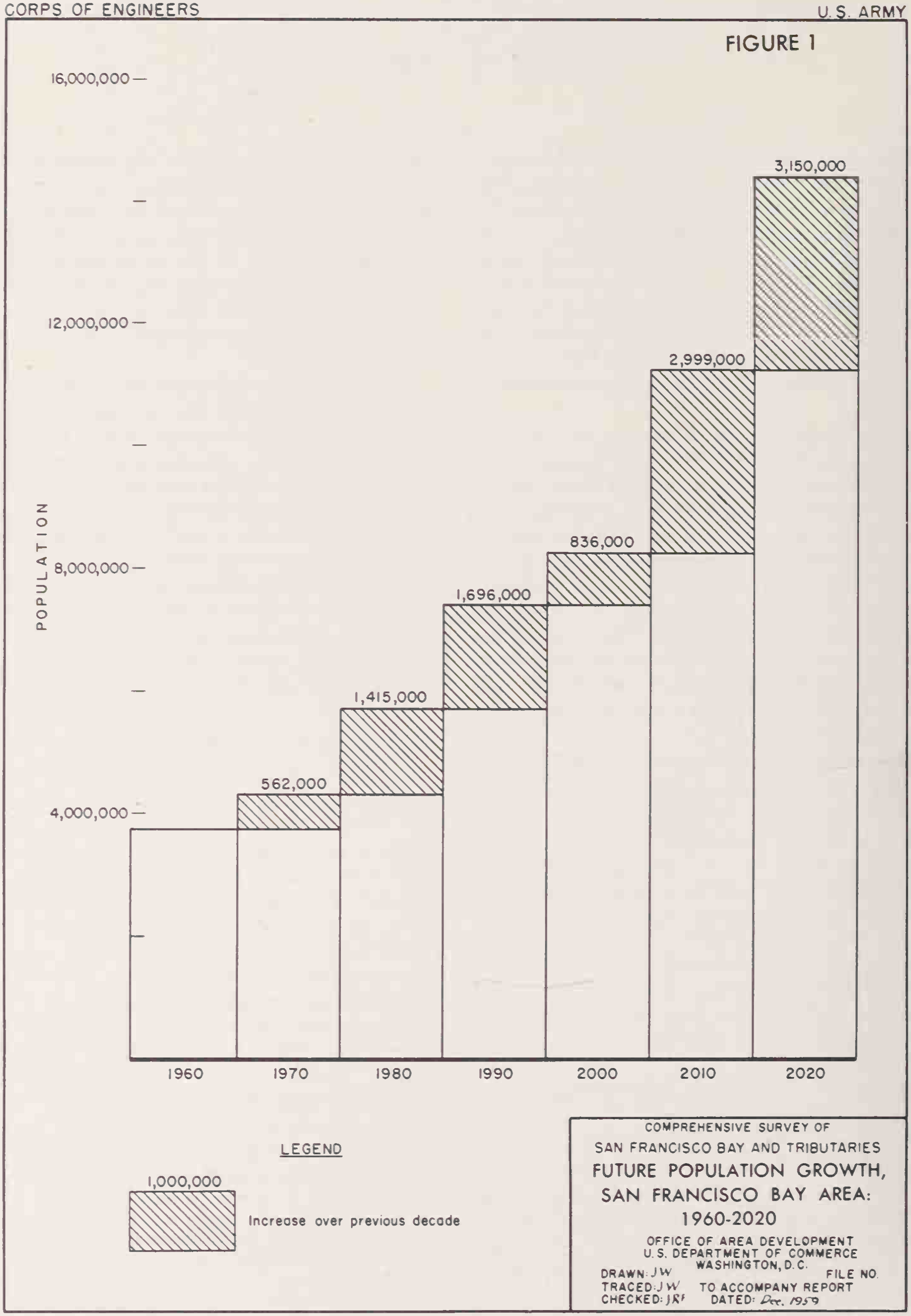

FIGURE 1

COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES
FUTURE POPULATION GROWTH,
SAN FRANCISCO BAY AREA:
1960-2020

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Table 1.—Summary of Population Projections for San Francisco Bay Area: 1960, 1990, 2020[1]

[In thousands]

	1960	1990	2020
Bay Area total	3, 752	7, 425	14, 410
San Francisco	793	938	1, 018
South Bay counties	2, 448	5, 099	9, 674
Alameda	954	1, 673	2, 854
Contra Costa	396	961	2, 140
San Mateo	441	933	1, 749
Santa Clara	657	1, 532	2, 931
North Bay counties	511	1, 388	3, 718
Marin	152	347	790
Napa	67	193	655
Solano	141	362	1, 116
Sonoma	151	486	1, 157

[1] Table 1 is based on table 5. For discussion of differences between figures in tables 5 and 7, see p. 22.

(*b*) *South Bay population will quadruple by 2020.*—From 1960 to 1990, population in the South Bay counties of Alameda, Contra Costa, San Mateo, and Santa Clara is expected to more than double from 2.4 million to 5.1 million—an increase of 2.7 million. From 1990 to 2020, the population of the South Bay counties is expected to nearly double again from 5.1 million to almost 10 million. By 2020, the South Bay counties will have 67 percent or two-thirds of total Bay Area population; this compares closely with the 65-percent share these counties are expected to have in 1960. (See fig. 2.)

Signs point to spectacular population growth in the South Bay counties in the next 60 years. By 2020, the population of Contra Costa County is expected to increase to more than five times its 1960 population. During the same period, San Mateo and Santa Clara Counties will approximately quadruple in population, while Alameda County is expected to triple its 1960 population.

Population densities of the South Bay counties are expected to double, from an average South Bay density of nearly 800 persons per square mile in 1960 to almost 1,600 by 1990. By 2020, the South Bay density will be nearly 3,000 persons per square mile or close to four times the 1960 density.

These projections reflect the strong economic potential of the South Bay for future growth. The South Bay counties offer ample land for industrial, commercial, and residential development, with approximately 1,770 square miles of land available for these purposes.

It is expected that the present, strong growth trend southward will continue. Through 1970, major growth in the South Bay area will be in San Mateo County, northern Santa Clara County, and western Alameda County.

(*c*) *North Bay population to increase nearly eight times by 2020.*—The North Bay counties, which are expected to increase from 0.5 million in 1960 to 1.4 million in 1990, should experience their greatest growth in the latter decades, rising from 1.4 million in 1990 to 3.7 million by 2020.

Twenty-six percent of the total Bay Area population in 2020 will live in the North Bay counties, as compared to 19 percent in 1990 and 14 percent in 1960. North Bay densities will increase from over 100 persons per square mile in 1960 to 1,000 in 2020. By the end of the 60-year period, 1960–2020, Marin will have increased its population by approximately 5 times, Napa by about 10 times, and Solano and Sonoma about 8 times.

As is presently the case with Marin, major future growth of Napa and Sonoma Counties is most likely to be concentrated in their southern sections which border the Bay. For a considerable part of the projection period, the character of this growth is likely to be predominantly (but not exclusively) suburban. As the southern reaches of Marin and northern East Bay residential areas become more crowded, the Bay Area's expanding population will find the southern portions of neighboring Sonoma and Napa Counties increasingly attractive for residential development.

(*d*) *Cities of San Francisco, Oakland, and Alameda will grow slowly.*—San Francisco County, because of the high population densities already attained, will show the least growth of Bay Area counties from 1960 to 2020, increasing from 793,000 in 1960 to 938,000 in 1990, and reaching 1,018,000 by 2020. Like San Francisco County, the central cities of Oakland and Alameda will also continue to grow at a slow rate.

(*e*) *Alameda and Santa Clara will be most populous counties.*—By 1990, Alameda County, with 1,673,000 persons will be the most populous county in the Bay Area, while Santa Clara will be in second position with 1,532,000, Contra Costa third with 961,000, and San Mateo fourth with 933,000. The 2020 rank of Bay Area counties in population will be:

Santa Clara	2, 931, 000
Alameda	2, 854, 000
Contra Costa	2, 140, 000
San Mateo	1, 749, 000
Sonoma	1, 157 000
Solano	1, 116, 000
San Francisco	1, 018, 000
Marin	790, 000
Napa	655, 000

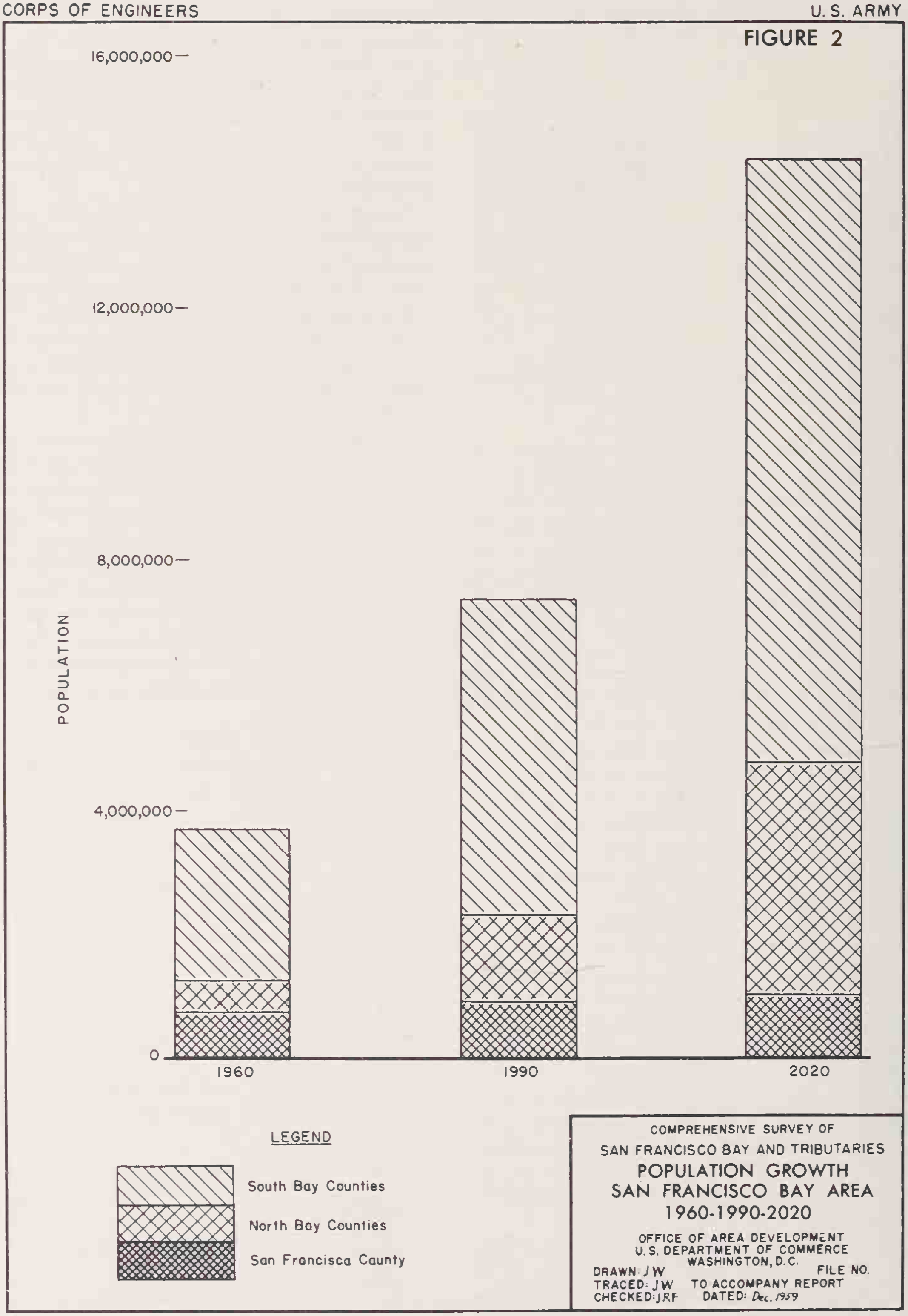

FIGURE 2

COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES
POPULATION GROWTH
SAN FRANCISCO BAY AREA
1960-1990-2020

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(*f*) *Adjusted population projections eliminate 30-year cyclical movements in economy.*—It will be noted that the population projections recommended for use in this project describe irregular growth curves inasmuch as they reflect the effects of the two 30-year cycles assumed for the economy. Since the report will come to the attention of some individuals or organizations who might wish to use population figures which follow the anticipated secular curve for 60 years, an alternative or adjusted series eliminating cyclical movements is presented for 1960, 1990, and 2020 in table 2. (Data for these and intervening periods are included in table 7, ch. II.)

Table 2.—Summary of Adjusted Population Projections for San Francisco Bay Area Counties: 1960, 1990, 2020

[In thousands]

	1960	1990	2020
Bay Area total	3, 752	6, 870	14, 420
Alameda	954	1, 560	2, 850
Contra Costa	397	860	2, 120
Marin	151	320	790
Napa	67	180	660
San Francisco	793	940	1, 020
San Mateo	442	840	1, 750
Santa Clara	657	1, 420	2, 950
Solano	141	330	1, 120
Sonoma	150	420	1, 160

7. *Outlook for Employment Growth*

(*a*) *Bay Area employment expected to reach 5,331,000 in 2020.*—Future Bay Area employment will increase from 1,471,000 in 1960 to 2,969,000 in 1990 and to 5,331,000 in 2020. (See table 3 and fig. 3.) Three major segments of the Bay Area economy (manufacturing, wholesale and retail trade, and services) will provide nearly three-fourths of all jobs in the Bay Area in the next 60 years. At present, these three segments of the Bay Area economy employ about 958,000 workers, or 65 percent of all employees in the Bay Area. By 2020, these three categories will account for 3,816,000, or 72 percent of all Bay Area employment.

(*b*) *Manufacturing employment will triple by 2020.*—Over the next 60 years, manufacturing employment is expected to increase from 316,000 workers in 1960 to 775,000 workers in 1990 and to 1,279,000 in 2020. Manufacturing will have a higher percentage share of Bay Area total employment in 1990 (26 percent) than in 2020 (24 percent) or in 1960 (22 percent).

Table 3.—Summary of Projected Future Employment, by Major Industry Divisions, San Francisco Bay Area: 1960, 1990, 2020

Industry	Number of employees (in thousands)			Percent change, 1960–2020
	1960	1990	2020	
All industries	1, 471	2, 969	5, 331	+262. 4
Construction	97	157	272	+180. 4
Manufacturing	316	775	1, 279	+304. 7
Transportation, communications, and utilities	150	249	443	+195. 3
Wholesale and retail trade	321	674	1, 263	+293. 5
Finance, insurance, and real estate	85	163	309	+263. 5
Services	321	680	1, 274	+296. 9
Government	116	232	443	+281. 9
Agriculture	60	36	43	−28. 3
All other	5	3	5	....

That manufacturing will continue to grow in the San Francisco Bay Area is indicated by an analysis of the area's industrial potential and, to a degree, by the results of the national sample survey of business and industry plans for expansion in the Bay Area conducted by the Office of Area Development with the cooperation of the Business and Defense Services Administration, U.S. Department of Commerce. This sample survey obtained information on present plans of industries and businesses in the United States for expanding manufacturing and distribution facilities or building new facilities in the Bay Area over the next 10 to 15 years. (See ch. III.) Following are some of the key findings of this sample survey:

(1) *35,000 new manufacturing jobs.*—Six major manufacturers (not now located in the Bay Area) were identified as planning new manufacturing facilities over the next 15 years.

(2) *Chemical industry.*—Cited as possibilities for development in the Bay Area were refineries, petrochemical plants, and plants to produce fertilizers, sulphuric acid, plastics, cement, and compressed and industrial gas.

(3) *Business machines and electronics industries.*—Plans of these industries indicated increasing production of computers and entrance into the manufacture of new products.

(4) *Food products industry.*—This industry is expected to expand food processing and distribution facilities in step with population growth in the West, California, and the Bay Area. This expansion is already underway.

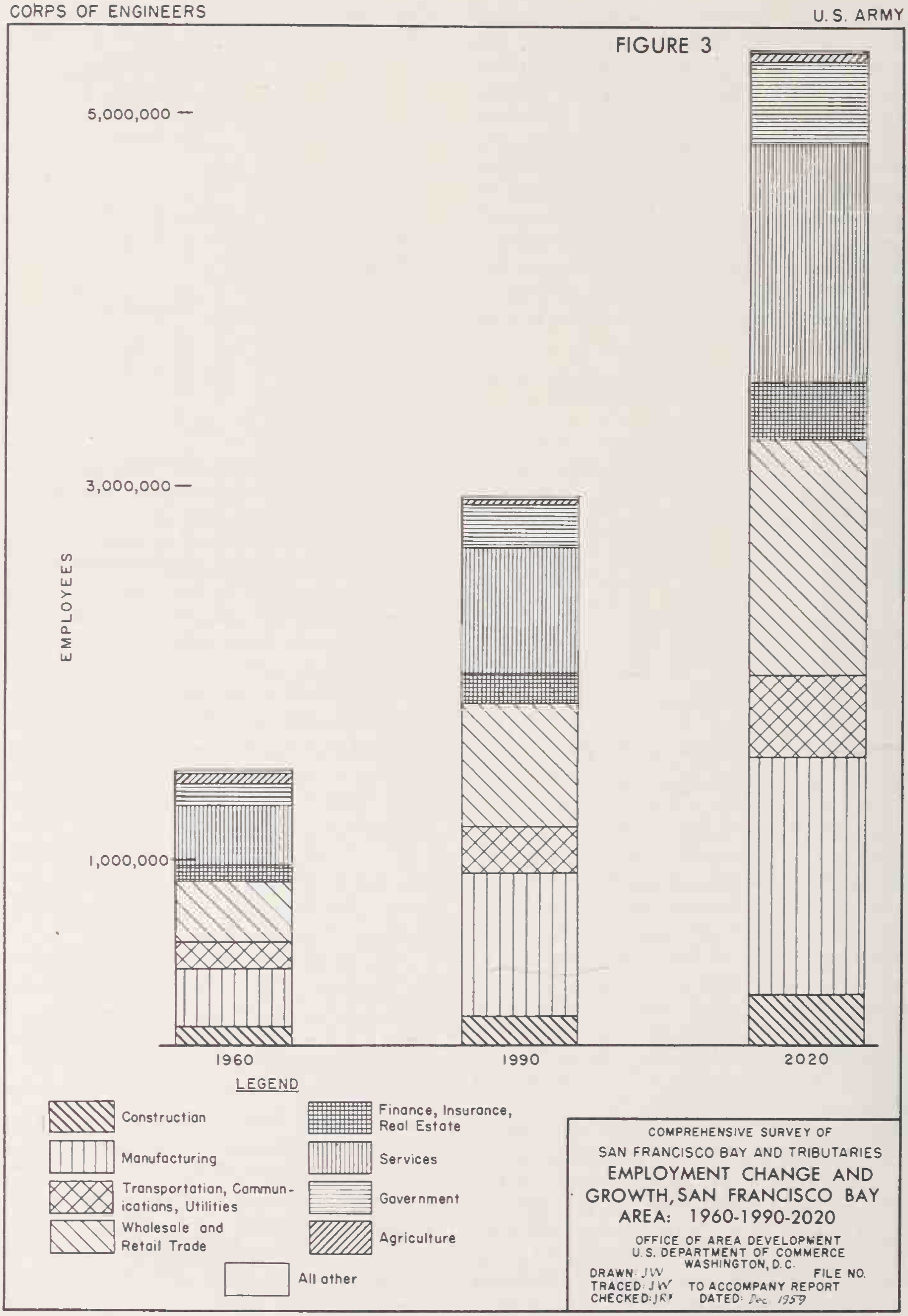


FIGURE 3

COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES
EMPLOYMENT CHANGE AND GROWTH, SAN FRANCISCO BAY AREA: 1960-1990-2020
OFFICE OF AREA DEVELOPMENT
U.S. DEPARTMENT OF COMMERCE
WASHINGTON, D.C.

(5) *Packaging and containers.*—The West Coast is a growth area for packaging and containers. More and more firms in this field are studying the West Coast and the Bay Area and planning future operations there. This interest in the Bay Area is occasioned by the diversity of product lines manufactured in the Bay Area and California which warrant diversified packaging services. The future growth of the container and packaging industry on the West Coast will exceed the national rate of growth for this industry.

(6) *Steel.*—An integrated steel mill operation is a possibility for the Bay Area within the next 5 to 10 years. The feasibility of such an operation is being carefully studied by one major steel corporation. Products of such an establishment would provide impetus for expanded operations by producers of a variety of durable goods.

(7) *Other industries.*—Additional industries were cited as having strong possibilities for future growth on the West Coast and in the Bay Area over the next 10–15-year period. These include building materials, printing and publishing, aluminum fabrication, research and development laboratories, furniture, and service and supply industries such as tool and die shops, welding shops, and industrial equipment and machinery manufacturing.

The long-term significance of these findings rests on the type of developments in store. As the area's industrial structure becomes more complex, the probability of further industrialization increases greatly.

Additional factors which argue for a vigorous future growth of manufacturing in the Bay Area were identified by the economic and land-use studies (chaps. III and IV). These factors are: First, manufacturing in the Bay Area is relatively underdeveloped and will grow to meet the increasing demands of western, California, and Bay Area markets; second, there is ample land in suitable locations available in the Bay Area; third, research and scientific facilities and personnel available locally together will serve as an incubator for new products industries and will help attract new engineer or technically based industries; fourth, the Bay Area's growing diversity of manufacturing operations and its expansion into the area of "growth" industries such as electronics and automation devices, industrial machinery, transportation equipment, and chemicals, increase the opportunity for Bay Area manufacturers to share in the exceptional growth outlook of these industries; and fifth, possible increases in freight-rate levels in the future for manufactured eastern goods moving to the Far West probably will encourage the development of more branch manufacturing facilities to serve the Bay Area and Western States.

8. Future Industrial Development in South Bay and North Bay

Presently, the most intensive industrial and commercial development is in the southern portion of the Bay Area. It is expected that the many advantages offered to industry by the South Bay counties—developed industrial parks and other suitable plant sites, transportation facilities, desirable residential sites, service industries, research facilities, and utility services—will assure that the larger share of industrial and business newcomers to the Bay Area will locate in the South Bay area for the next several decades.

However, some industrial development is already taking place in the North Bay counties, and there are possibilities for developing both heavy and small industries in that area. Sonoma County, for example, has possibilities for future development for food-processing industries, wood-processing plants, research and development laboratories, and small electronic and other engineer-based industries.

The southeastern half of Solano County should become increasingly attractive to heavy industries in search of unrestricted locations served by navigable waterways. Chemical plants, pulpmills, and paper companies are currently considering the area.

Nevertheless, intensive industrial development of the North Bay counties is not anticipated for a decade or two because ample industrial land is still available in more highly developed southern counties and near expanding Central Valley communities to the east of the Bay Area.

9. Wholesale and Retail Employment Expected To Quadruple by 2020

Wholesale and retail employment will more than double from a total employment of 321,000 in 1960 to 674,000 in 1990. By 2020, wholesale and retail trade will account for 1,263,000 jobs.

Wholesale and retail trade will increase their percentage share of total employment from 21.8 percent in 1960 to 22.7 percent in 1990 and to 23.7 percent in 2020. Wholesale and retail trade will rank second to services in number of employees, more than three-fourths of whom will be needed to meet the trade requirements of the local population. Something less than a fourth of the remaining employment (mainly wholesale activity) will exist to meet requirements of foreign markets, markets concentrated elsewhere in northern California, and neighboring counties in western Nevada. In general, however, the Bay Area's position in wholesale operations is expected to lose ground in relation to Los Angeles and the major urban centers in the Central Valley. The rate of growth of retailing, on the other hand, is expected to remain in step with population growth and probably to exceed it; this optimistic outlook is based on the Bay Area's established position as a purveyor of specialty goods and on the probability that per capita consumption expenditures will continue to rise.

10. Services to Undergo Large Expansion

In the future, services will provide more jobs in the Bay Area than will the wholesale and retail trade segments of the economy, and nearly as many jobs as manufacturing. In 1960, services will account for 321,000 jobs, in 1990 for 680,000 jobs, and in 2020 for 1,274,000 jobs. Continuing expansion of employment in services is based upon the expectation that, as income levels rise, more disposable income will be budgeted for a wide array of business, personal, technical, and professional services. (It is generally true that, as society becomes more advanced technically, demand for professional services is expected to advance at an accelerated pace.) It is expected finally that the Bay Area will obtain a growing portion of its income from the tourist trade.

11. Transportation Employment to Increase by 293,000 Employees

The transportation industry, which includes communications and utilities, will increase in employment by 293,000 during the period 1960 to 2020. This will constitute a reduction of transportation's share of total employment from 10 percent in 1960 to less than 9 percent in 2020. Use of laborsaving devices and additional supplementation of railroad transportation by truck transportation together will contribute to the proportionate reduction in transportation as a source of employment.

12. Government Employment Will Add 327,000 Employees by 2020

Employment in government in the Bay Area is expected to increase from 116,000 in 1960 to 443,000 by 2020—an increase of nearly 300 percent. This increase is based on the expectation that the Bay Area will retain its well-recognized position as the regional headquarters for many governmental and military functions.

The greatest increase in the future in the government category will result from the addition of substantially larger numbers of employees at State and local levels. This will follow from an increase in population and the accompanying need for services in such fields of public responsibility as education, health, safety, roads and municipal utilities.

13. Finance, Insurance, and Real Estate

Employment in finance, insurance, and real estate is expected to rise with overall growth of the Bay Area. As the industrial structure becomes more complex, it is expected that the Bay Area will grow appreciably as the primary regional center for financial and insurance services. Consequently, this area of employment not only will grow, but it is likely to become proportionately more important than it is at present.

14. Construction Activities

The Bay Area will remain a headquarters and operating center for construction activities that operate throughout the world. The chief reason for the growth of employment in this industry, however, will be the construction demands of a rapidly expanding local population.

15. Agriculture and Extractive Industries

Agriculture and extractive industries (mining, forestry, and fishing) are all expected to provide less employment in future decades than they do at present. A decline in agriculture is clearly indicated, principally because of the gradual absorption of agricultural lands for residential, industrial, and similar more profitable uses.

16. Outlook for Land Use

(a) Urban land potential sufficient for future Bay Area needs.—About 600 square miles of urban land (residential, commercial, industrial—see p. D–1,

app. D) will be occupied in the Bay Area in 1960. This requirement for urban land is about one-sixth of the 3,600 square miles of land deemed suitable and available for urban development in the Bay Area. It is estimated that 2,400 square miles of land, or two-thirds of the available area, will be in urban use by 2020. (See table 4 and fig. 4.)

Urban encroachment onto agricultural lands and an increasingly intensified use of both urban and remaining agricultural lands will be the dominant land-use trends in the San Francisco Bay Area over the next 60 years. The process may be defined as the "filling in" of present land-use patterns and the shift of agricultural land to urban use at the margins and at the future extensions of existing urban development.

Table 4.—Future Land-Use Distribution, San Francisco Bay Area: 1960, 1990, 2020

[*In square miles*]

Land use	1960	1990	2020
Bay Area total	6, 958	[1] 6, 963	[1] 6, 976
Industrial	98	183	310
Residential and commercial	518	1, 112	2, 079
Urban land subtotal	616	1, 295	2, 389
Agricultural	4, 300	3, 705	2, 810
Other [2]	2, 042	1, 963	1, 777

[1] Increases in total land in the Bay Area result from additions through land reclamation of tide and submerged lands—5 square miles by 1990 and another 13 by 2020, making a total of 18 square miles between 1960 and 2020.

[2] Includes underdeveloped and waste land, public and reserved land, and salt ponds.

The 2020 land pattern should be an extension of present urban uses along existing and improved transportation routes and intersection connectors. The present urban pattern, with a regional center at San Francisco-Oakland and extending along both sides of San Francisco Bay in front of the alining foothills, will coalesce and extend farther into Santa Clara County. Concentration of heavy industry along the deepwater north shore of Contra Costa County will continue. Dispersed settlement in the northern counties and in the connecting valleys east of the Bay will grow steadily but at a slower rate.

The present pattern of land use in the older urban sections will continue as at present, with some exceptions due to local influences and government action. Future use of reclaimed land for urban purposes will be minor as compared with urban inroads onto lands presently in agricultural use.

(*b*) *Industrial land use to triple; residential and commercial land use to quadruple.*—In 1960, approximately 100 square miles of land will be required for industry, more than 500 square miles for residential and commercial use, and approximately 4,300 square miles will be used for agriculture. By 1990, industry is expected to require close to 200 square miles and residential and commercial uses over 1,100 square miles, while agriculture will be reduced to about 3,700 square miles. By 2020, industrial land will have increased to over 300 square miles, residential and commercial land to nearly 2,100 square miles, and agricultural land will have declined to 2,800 square miles.

By 2020, land suitable for urban purposes in the South Bay will be completely occupied by industrial, commercial, and residential activities. By contrast, the North Bay counties will still have land available for urban development, and as the pressure for land grows in the southern counties, urban development may be expected to increase in Napa, Solano, and Sonoma Counties.

17. South Bay Land-Use Trends

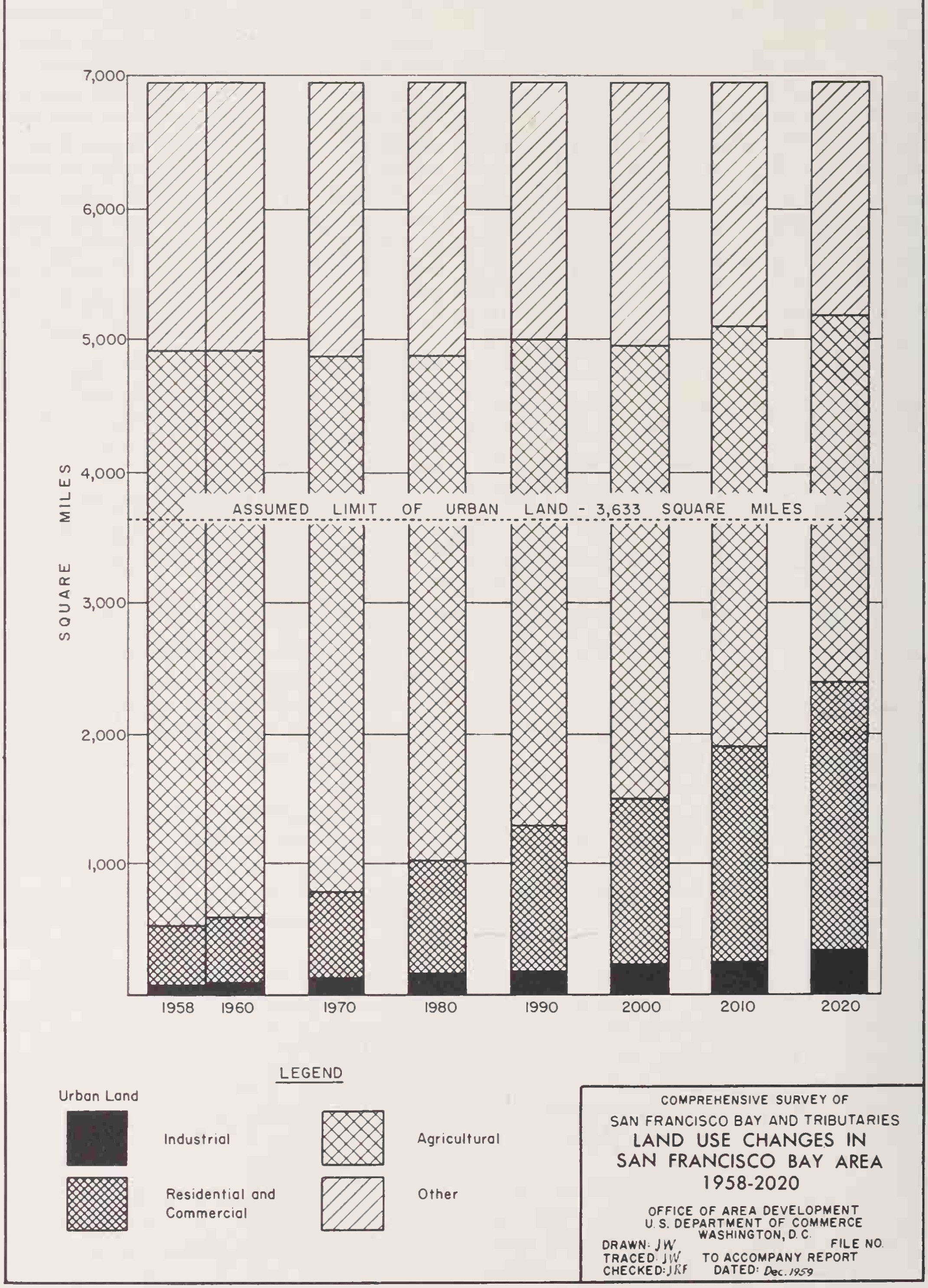
The South Bay counties of Alameda, Contra Costa, San Francisco, San Mateo, and Santa Clara will have 80 square miles of land occupied by industry in 1960; by 2020, more than 200 square miles of land in these counties are expected to be in industrial use.

Residential and commercial uses, which will require about 400 square miles of land in 1960, will need 1,300 square miles by 2020. During the same period, land devoted to agriculture will decline from 1,900 square miles in 1960 to about 1,100 square miles in 2020.

In the South Bay, excluding San Francisco, San Mateo is the most highly developed in urban land—38 percent of potential urban land in 1958. Well over one-third of the potential urban land in that county will be in urban development in 1960. Urban development in Alameda County is the most extensive, covering 106 square miles in the county in 1958. Contra Costa County is the least developed in the South Bay, with about 110 square miles, or 19 percent, of the approximately 580 square miles of potential urban land expected to be in urban use in 1960.

CORPS OF ENGINEERS U. S. ARMY

FIGURE 4



COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES
LAND USE CHANGES IN
SAN FRANCISCO BAY AREA
1958-2020

OFFICE OF AREA DEVELOPMENT
U. S. DEPARTMENT OF COMMERCE
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18. North Bay Land-Use Trends

The North Bay counties of Marin, Napa, Solano, and Sonoma will have almost 20 square miles of land devoted to industrial use in 1960; by 2020, industrial land in use will total nearly 70 square miles.

Residential and commercial uses, which will require a little over 100 square miles in 1960, will increase their requirement to about 780 square miles by 2020. During the same period, land devoted to agriculture will decline from about 2,400 square miles in 1960 to somewhat over 1,700 square miles in 2020.

In the North Bay area, there is a sharp contrast between counties as to land in urban use in 1960 and the total potential available for urban development. In 1960, Marin County is expected to have developed about 14 percent of its urban land potential, making it the most extensively developed of all North Bay counties in that year. This compares with second-ranking Solano County, which is expected to have slightly over 6 percent of its urban land potential developed in 1960, Napa County with less than 6 percent developed, and Sonoma County with about 4 percent developed.

19. Outlook for Land Reclamation

On the basis of past rates of reclamation, and taking into account increasing costs, it appears likely that by 1990 much of the remaining marshland in the Bay Area may have been reclaimed for various purposes, among which recreational purposes may be comparatively important.

Because of steeply rising costs for reclamation of the deeper water areas and a number of unfavorable physical factors, only a comparatively small percentage of the tide and submerged lands susceptible of reclamation will eventually be reclaimed.

Even when the pressure of population becomes much greater than it is at present, making economically feasible and socially desirable many things which are not so now, it will still be wise to strike a balance between reclamation and conservation of water areas. (See ch. V, p. 75, for definitions of three classifications of reclaimed land.)

20. Reclamation for Public Projects

Needs for portions of all three categories of potential land—marshlands, tidelands, and submerged lands—undoubtedly will arise with greatly increased density of population. Additional flatland will be needed for port development, for new airports, for new highspeed roads, for industry, and for other purposes. It is estimated that, in 2020, the area of land beyond the present shoreline in use for industrial purposes, port facilities, commercial airports, public utilities, and railroad emplacements will be about 18 square miles (estimate from land-use maps), a relatively small figure in comparison with the total amount of nearly 250 square miles of tide and submerged lands considered susceptible of reclamation. It seems highly likely, however, that much of the future reclamation of tide and submerged lands (including, probably, some marshlands) will be of the multipurpose shore-development type, to be used for highways of the freeway type (near, but partly off, the present shores); for recreational areas of different types, including boating, fishing, and hunting facilities; for new airports; and perhaps even for certain types of housing.

Thus, the final area of tide and submerged land reclaimed by 2020 may be considerably larger than 18 square miles. However, as the extent of multipurpose reclamation cannot be foreseen at this time, it is not practicable to estimate precisely what this amount is likely to be.

Chapter II. Population Growth and Distribution

ASSUMPTIONS

In preparing this population study, it was necessary to make a cursory evaluation of the future implications of recent population and economic trends, from which several basic assumptions concerning future population, economic, and other trends were derived. These assumptions are:

(*a*) *Population trends.*—There will be continued national population and economic growth to the year 2020 (see par. (*d*)(1), p. 16). The Bay Area will continue, as in the recent past, to obtain a gradually increasing share of the national population from decade to decade, but a slightly lesser share of future California population growth. (See par. (*d*)(2), p. 16, and par. A–3, pp. A–4 and A–6, app A.)

(*b*) *Economic trends.*—Indications are that the Bay Area will soon complete the economic assimilation of its recent, large population gains. This accomplishment alone will stimulate the area's overall economic growth.

Future manufacturing employment in the Bay Area will constitute a greater percentage of total future Bay Area employment than at present. Likewise, employment in trade and employment in services will increase their percentage shares of total employment, while agricultural employment will decline. (See pp. 44–50, ch. III.)

(*c*) *Land use.*—Basic land-use patterns and relationships will not change radically in the future, although significant expansions and moderate changes in land requirements will occur. Industry will require more land per employee in the future and continue to disperse to outlying areas, and other land uses also will expand outward into agricultural lands. (See p. 60, ch. IV.)

Natural waterways and transportation have been the key factors in determining the basic patterns of metropolitan land use in the past—from the high population and building concentrations of the horse-drawn carriage and streetcar era to the less dense and satellite communities made possible by the automobile and rapid transit. Radical changes in metropolitan patterns of population and land-use distribution can be expected only if there are developed transportation media as convenient as and much more rapid than the automobile, but not excessively more expensive. Such developments would change land use in the direction of less concentration and greater dispersion, with the degree of change in land-use patterns being dependent on the increase in the effective rapidity of the new transportation media. (See also pp. 61–62, ch. IV.)

(*d*) *Water availability.*—Sufficient water will be available for the future commercial, industrial, residential, and other water needs of the projected population and will not be a limiting factor on growth. (See p. 61, ch. IV.)

PROCEDURE AND METHOD

Population projections recommended for planning purposes in the San Francisco Bay Area were developed in several steps which included full consideration of the extensive economic, land-use, and population density studies included in this report. There follows a summary of the principal steps taken in preparing the recommended projections.

21. Evaluation of Previous Projections

The first step was to review and evaluate previous population projections made for the Bay Area, California, and the Nation. In preparation for this review, previous projections and current information on population trends were obtained in the field and from Federal agencies in Washington, D.C. In California and the San Francisco Bay Area, information was obtained from the Federal Reserve Bank of San Francisco, the California Department of Finance, the California Department of Water Resources, the California Department of Employment, and the California Division of Highways. Other agencies, firms, and groups contacted include the San Francisco Department of City Planning, the Oakland Department of City Planning, other city and county planning agencies in the Bay Area, the area development departments of railroads and utilities, local development agencies, private industries, research institutions and consultants, and universities.

Earlier population projections for the San Francisco Bay Area were reviewed and evaluated. The results of this analysis were published in October 1957 by the Office of Area Development for the U.S. Army Engineer District, San Francisco, Corps of Engineers, under the title "Economic Aspects of Survey for the Comprehensive Development of San Francisco Bay and Tributaries, Part I: Evaluation of Existing Population Projections." (For summary of this report, see app. B, pp. B–1—B–3.) In making this evaluation, the Office of Area Development obtained the advice and suggestions of a special advisory committee which included representatives of the Population Division of the U.S. Bureau of the Census, U.S. Department of Commerce, the Office of Statistical Standards of the U.S. Bureau of the Budget, and the Bureau of Standards, U.S. Department of Commerce.

In view of the need for figures for preliminary planning purposes, the evaluation report recommended the highest of previous projections for these purposes; it pointed out that even these figures might be too low in light of more recent information. This recommendation took into account that the recommended "high" projection was based on lower national and State projections than were indicated by new Census projections made available to the Office of Area Development when evaluation of previous projections was underway. These revised State and national estimates were later published by the Bureau of the Census (97).[2]

22. *Census Projections to Establish Range of Future Population Growth*

As the new Census projections mentioned above indicated higher growth to 1980 in the Nation, Western States, and California than had been projected previously by the Bureau, it was concluded that the Bureau of the Census should make new long-range estimates of National, State, and San Francisco Bay Area population by decades. (As of the date of publication of this report, the Bureau of the Census was not preparing population projections beyond 2010.) It was desired that these projections reflect the latest information available to the Population Division of the Bureau of the Census concerning trends in the birth rate at national and regional levels. (For assumptions and method used, see app. B, pp. B–5—B–8.)

In response to this request of the Office of Area Development, the Bureau of the Census prepared:

(1) Estimates of the 1956 population of the United States, California, and the San Francisco Bay Area. (See app. B, pp. B–4—B–5, table B–2, 1956 column.)

(2) Two projections of population for the Nation under assumptions of both low and high birth rates, by decades, from 1960 to 2010. (See app. B, p. B–3, table B–1, United States Series 1–II and Series 1–IV.)

(3) Four projections of population for California assuming four different levels of fertility, by decades, from 1960 to 2010. (See app. B, p. B–3, table B–1, California Series 1–II, 2–II, 1–IV, and 2–IV.)

(4) Four projections of population for the Bay Area under four different assumptions of fertility, by decades, from 1960 to 2010. (See app. B, p. B–3, table B–1, San Francisco Bay Area Series 1–II, 2–II, 1–IV, and 2–IV.)

(5) Projections of population for the Bay Area counties, by decades, from 1960 to 2010. (See app. B, pp. B–4—B–5, Bay Area counties Series 1–II, 2–II, 1–IV, and 2–IV.)

23. *Preparation of Single Recommended Projections for Planning Purposes*

The Census projections served the purpose of establishing the overall magnitude and probable range of future population for the Nation, California and the San Francisco Bay Area under the optimistic conditions assumed herein. There remained, however, the task of developing a single set of recommended population projections for planning purposes for the Bay Area as a whole for each decade to 2020 and a single set of recommended population projections for civil divisions within the Bay Area for each decade to 2020.

To meet this need for a single set of projections for planning purposes for the Bay Area and to anticipate the future distribution of these recommended population estimates on a township basis within the Bay Area involved the following operations:

(*a*) *Preparation of preliminary population estimates.*—A new method for projecting and distributing population was used to prepare preliminary estimates of future population for townships, counties, and the San Francisco Bay Area for each decade to 2020. This method for projecting and distributing population—the Area Density Method—

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[2] Number in parentheses indicates source reference as listed in bibliography. (See app. E.) Additional notations within parentheses refer to contents of cited reference.

was developed and used by the Office of Area Development because of certain advantages it enjoys over other methods of population projection.

The method takes into account and classifies the various types of local small area growth patterns within the present urbanized areas and projects these patterns or profiles of growth for the appropriate nonurbanized portions of the metropolitan area on the basis of economic and geographic similarities and in light of the rate of spread of the urban complex as a whole.

The Area Density Method makes possible population estimates for small areas (minor civil divisions) within a metropolitan area; permits detailed estimates for short-time intervals; and facilitates correction or adjustment of projections to conform with new information and new trends. The breakdown by small areas permits correction for certain areas without affecting the other areas. (A detailed discussion of the Area Density Method appears in app. A.)

(*b*) *Field check of preliminary estimates.*—The preliminary estimates of future population and distribution derived by the Area Density Method were checked for reasonableness with city and county planning agencies, with State and local government agencies, and with economists of universities, banks, and industries in the Bay Area against information concerning local projects or plans which might accelerate or retard future population growth.

(*c*) *Preparation of basic studies for appraisal of population estimates.*—To test further the reasonableness of the preliminary estimates of future population and population distribution derived by the Area Density Method, it was necessary to develop fully basic information which would answer such questions as:

(1) Will there be sufficient national population and economic growth in the future to provide a basis for the regional and area growth envisioned? What are the reasonable limits of such growth at the national, regional, and local levels?

(2) Do California and the San Francisco Bay Area enjoy sufficient economic assets and advantages to enable them to obtain an increasing share of future U.S. economic and population growth? What can this share reasonably be expected to be?

(3) Can the type of economy which can be reasonably expected for the Bay Area in the future, based on the economic advantages the Bay Area enjoys, be expected to support the projected population?

(4) To what extent do present plans of U.S. industries for expanding and building new production and distribution facilities in the Bay Area indicate the reasonableness of the population and economic projections?

(5) Is there sufficient land of the right types and in the right places to meet the anticipated spread of the future population and the needs of the future economy in the Bay Area?

(6) Are the projected population densities for the Bay Area reasonable in the light of past experience with the densities of the Bay Area and of other, older metropolitan areas and cities in the United States?

To provide a basis for answering the foregoing questions, the following studies were prepared:

Economic Study (ch. III) includes consideration of future national and Bay Area growth based on U.S. Department of Commerce gross national product and population projections, on an appraisal of Bay Area competitive advantages for new employment, on plans of business and industry to increase employment in the Bay Area over the next 10 years, and on an analysis of the relationships of past and future population growth in the Bay Area and the United States.

Land-Use Study (ch. IV) provides information on the present land-use pattern of the Bay Area, measures the availability of land in the Bay Area, and projects a future land-use pattern within the Bay Area in terms of the probable requirements of the anticipated population and economy. (Maps showing land use in 1958 and projected land use for each decade from 1960 to 2020 for the Bay Area are in the plate supplement.)

Population Density Analysis (see pp. 26–27) compares projected Bay Area population densities with recent density experiences of the Bay Area and with the experiences of other cities and metropolitan areas in the United States. (For maps showing population distribution in the San Francisco Bay Area for each decade from 1960 to 2020, see plate supplement.)

Reclamation Study (ch. V) and *Waterborne Trade Study* (not included in this report; see Introduction, pp. XIX–XX), prepared by the Office of Area Development for this project, contributed information for use in appraising future land availability and the impact of possible future waterborne trade development on the San Francisco Bay Area economy. (For maps showing lands susceptible of reclamation in the Bay Area, see plate supplement.)

(*d*) *Final appraisal of area density population projections and allocations.*—The studies made in (*c*), above, provided the following basic conclusions with reference to the outlook for population and economic growth of the Nation, California, and the San Francisco Bay Area:

(1) National population will grow to about 418,000,000 by 2020 (an extrapolation to 2020 by the Office of Area Development of a 2010 definitive projection of 370,000,000 prepared by the Office of Business Economics, U.S. Department of Commerce—see fig. 5, and reference 159 in Bibliography, app. E). This represents, in the next 60 years, a population growth of nearly 2½ times the estimated 1959 population of 177,000,000. According to the same source, by 2020, gross national product may be expected to exceed $3,000 billion in current dollars, or about seven times the 1958 gross national product of $442 billion.

(2) The economic advantages enjoyed by California and the Bay Area as outlined in Chapter III, Employment and Economic Growth, indicate that the Bay Area will continue to obtain a gradually increasing share of the Nation's population from decade to decade to 2020. (See pp. 49–50, ch. III). This share is expected to increase from 1.7 percent of the U.S. population in 1950 to more than 3 percent in 2020. This increase seems reasonable, not only on the basis of the various studies already described in this section, but also in view of the projected population for the Bay Area for 2020 which actually represents a smaller portion of the estimated population for California as a whole than is currently the case. Specifically, the estimated 2020 Bay Area population of 14,400,000 represents 19.7 percent of California's projected population of 73,000,000 (the Census "high" estimate for 2010 as extrapolated to 2020) as against a share of 25.3 percent in 1950 (2,681,000).

(3) That the Bay Area will be capable of the economic support of a population of over 14 million is indicated by independent economic projections made by the Office of Area Development to the year 2020, by land-use studies to determine the availability of land for the future projected population and for the various projected economic activities, by a study of the economic growth stimuli present in the Bay Area, by examination of Bay Area competitive advantages for new economic activity, and by a sample survey of present United States industry plans for expanding employment in the Bay Area. (See pp. 50–52, ch. III.)

(4) The sample survey of new manufacturing employment now planned by United States industries in the Bay Area over the next 10 years indicates immediate population and economic growth, which is reflected in the estimates for 1970. More than 35,000 manufacturing jobs—close to a third of the projected increase of 126,000 manufacturing jobs for the Bay Area between 1960 and 1970—were identified with plans of companies as revealed by the sample survey.

(5) The anticipated future spread of population and the land requirements of the various elements of the projected economy in the Bay Area can all be comfortably accommodated by the available land in the nine counties of the Bay Area. Total urban land available for development in the Bay Area as estimated in chapter IV (Land for Urban Needs) will be 3,600 square miles, as compared to 2,400 square miles total requirements for urban land in the Bay Area by 2020. Future expansion of urban land will take place primarily at the expense of present agricultural lands.

(6) When the projected population densities for the Bay Area are compared to the density experiences of older metropolitan areas and cities, they satisfy optimum density criteria. (See pp. 26–27.)

It is noteworthy also that the population estimates obtained through the Area Density Method fall well within the range of projections made by the Bureau of the Census. Figure 6 compares the area density projections with the Census Series 2–II (high) projection of 14,789,000 for 2010, with the Census Series 1–IV (low) projection of 8,990,000 for 2010. It is evident that the area density projection is slightly above the median point of the Census 2–II (high) and 1–IV (low) projections.

RECOMMENDED POPULATION AND POPULATION DENSITY PROJECTIONS: 1960–2020

The recommended population projections and densities derived by the Area Density Method for the San Francisco Bay Area and townships and counties for each decade from 1960 to 2020 are presented in tables 5 and 6.

These projections assume that, during the next 60 years, economic and population growth will occur in two successive 30-year cycles. Consequently, irregularities in the future growth rate are attributable, not only to variances in growth rate between subareas, but also to broad cyclical movements projected for the economy as a whole.

24. Determination of 30-Year Cycle

This assumption was made on the basis of the growth experiences of selected major United States cities during the period 1850–1950. The method used in determining the 30-year cycle is as follows:

(1) The United States and six major population areas (Chicago, Philadelphia, St. Louis, Los Angeles, Boston, and New York) were selected for study.

(2) The percentage increase in population by decades was determined for each area and the United States for the period 1850–1950.

(3) Shown graphically, the percentage increases indicated the cyclical patterns of population increase for the 100-year period for each area and the United States as a whole.

(4) The intervals between the troughs of the cycles for each area and the United States were computed, and the mean interval was found to be about 30 years.

The last periodic slowing down of national economic growth occurred approximately 30 years ago. Therefore, it was considered appropriate to start the two future 30-year cycles with which this report is concerned in the year 1960. It is further assumed that these two cyclical movements will describe "normal" growth curves. Consequently, there will be two periods of slower growth during the next 60 years. As charted, these will occur at the beginning of and midway through the study period.

Table 5.—Population Projections Based on Area Density Method for San Francisco Bay Area, Bay Area Counties and Townships: 1960–2020

[In thousands]

County and township	1960	1970	1980	1990	2000	2010	2020
Bay Area total	3, 752	4, 314	5, 729	7, 425	8, 261	11, 260	14, 410
Alameda	954	1, 048	1, 342	1, 673	1, 833	2, 343	2, 854
Alameda	67	69	76	83	86	93	100
Brooklyn	210	230	287	344	363	420	477
Eden	254	297	424	552	595	723	851
Murray	18	25	48	71	94	190	286
Oakland-Peralta	345	350	365	380	385	400	415
Pleasanton	19	23	34	81	93	140	187
Washington	41	54	108	162	217	377	538
Contra Costa	396	481	664	961	1, 105	1, 567	2, 140
Township 1 (Martinez)	18	22	38	53	69	115	162
Township 2 (Port Costa)	1	1	1	2	2	4	6
Township 3 (Walnut Creek)	69	97	104	132	160	244	328
Township 4 (Danville)	10	12	50	87	96	134	245
Township 5 (Concord)	53	78	102	174	199	271	343
Township 6 (Pittsburg)	38	42	57	101	116	160	205
Township 7 (El Cerrito)	28	31	40	49	52	60	69
Township 8 (Antioch)	16	19	32	44	47	60	97
Township 9 (Brentwood)	6	7	11	16	17	37	56
Township 10 (El Sobrante)	30	34	48	61	75	117	158
Township 11 (Pinole)	10	12	21	29	38	46	71
Township 12 (Crockett)	5	5	6	7	8	9	13
Township 13 (Mount Diablo)	(1)	(1)	1	2	2	4	5
Township 14 (Byron)	1	3	10	17	24	51	79
Township 15 (Richmond)	100	105	119	133	138	152	167
Township 16 (Port Chicago)	3	3	7	8	9	21	25
Township 17 (Oakley)	8	10	17	46	53	82	111
Marin	152	181	257	347	403	597	790
Novato	26	41	57	73	89	154	218
San Rafael	82	89	117	146	174	259	343
Sausalito	41	48	75	103	110	138	166
Tomales	3	3	8	25	30	46	63
Napa	67	81	126	193	243	449	655
Calistoga	3	3	3	4	6	11	16
Napa	54	67	111	155	198	378	558
St. Helena	10	11	12	34	39	60	81

See footnote at end of table.

Table 5.—Population Projections Based on Area Density Method for San Francisco Bay Area, Bay Area Counties and Townships: 1960–2020—Con.

[In thousands]

County and township	1960	1970	1980	1990	2000	2010	2020
San Francisco	793	841	889	938	986	1, 002	1, 018
San Francisco	793	841	889	938	986	1, 002	1, 018
San Mateo	441	511	716	933	1, 012	1, 381	1, 749
Township 1 (South San Francisco)	153	177	246	314	338	407	476
Township 2 (Belmont)	120	145	218	292	316	390	463
Township 3 (Redwood City)	136	149	202	255	268	425	583
Township 4 (Half Moon Bay)	4	9	13	28	44	106	168
Township 5 (Burlingame)	28	31	37	44	46	53	59
Santa Clara	657	827	1, 180	1, 532	1, 691	2, 298	2, 931
Burnett	7	13	33	53	73	155	237
Campbell	21	24	26	35	37	46	54
Fremont	85	109	133	158	182	253	325
Gilroy	23	54	85	117	148	277	406
Palo Alto	90	112	133	140	147	168	175
Redwood	36	41	46	68	73	137	200
San Jose	235	278	454	631	674	850	1, 026
Santa Clara	81	95	137	179	193	207	249
Saratoga	24	27	39	50	62	96	130
Sunnyvale	55	74	94	101	102	109	129
Solano	141	161	245	362	428	765	1, 116
Benicia	12	13	27	40	43	84	124
Denverton	(1)	(1)	2	7	9	14	37
Elmira	1	1	5	9	12	27	42
Green Valley	1	3	7	11	15	31	47
Maine Prairie	1	1	9	16	18	48	78
Montezuma	(1)	1	5	21	25	41	57
Rio Vista	3	6	14	22	30	63	97
Silveyville	5	7	9	17	25	58	91
Suisun	17	21	34	48	61	118	174
Tremont	1	2	6	23	27	45	62
Vacaville	8	11	20	28	31	67	102
Vallejo	92	95	107	120	132	169	205
Sonoma	151	183	310	486	560	858	1, 157
Analy	17	21	36	51	66	126	187
Cloverdale	5	6	10	15	20	36	51
Healdsburg	13	14	24	34	44	77	111
Petaluma	23	27	43	106	121	184	247
Redwood	5	6	7	8	9	18	27
Santa Rosa	62	80	150	221	238	309	380
Sonoma	26	29	40	51	62	108	154

[1] Less than 500.

Table 6.—Projected Population Densities for San Francisco Bay Area Townships: 1960–2020

County and township	Area in Square Miles,	Persons per square mile							
	1940	1950 [1]	1960	1970	1980	1990	2000	2010	2020
Alameda:									
Alameda	6. 5	9, 922	10, 307	10, 671	11, 751	12, 831	13, 195	14, 275	15, 355
Brooklyn	52. 8	3, 690	3, 985	4, 349	5, 429	6, 509	6, 873	7, 953	9, 033
Eden	118. 3	977	2, 143	2, 507	3, 587	4, 667	5, 031	6, 111	7, 191
Murray	263. 8	32	67	93	181	270	358	722	1, 086
Oakland-Peralta	13. 8	24, 185	25, 014	25, 378	26, 458	27, 538	27, 902	28, 982	30, 062
Pleasanton	129. 3	45	150	176	264	628	717	1, 080	1, 444
Washington	149. 0	113	273	361	725	1, 089	1, 453	2, 533	3, 613

See footnote at end of table.

Table 6.—Projected Population Densities for San Francisco Bay Area Townships: 1960–2020—Continued

County and township	Area in Square Miles, 1940	Persons per square mile							
		1950 [1]	1960	1970	1980	1990	2000	2010	2020
Contra Costa:									
Township 1 (Martinez)	42. 9	318	424	512	876	1, 240	1, 604	2, 684	3, 764
Township 2 (Port Costa)	5. 1	105	95	121	209	297	386	750	1, 113
Township 3 (Walnut Creek)	77. 7	347	882	1, 246	1, 334	1, 698	2, 062	3, 142	4, 222
Township 4 (Danville)	103. 0	29	92	118	482	846	934	1, 298	2, 378
Township 5 (Concord)	66. 9	382	797	1, 161	1, 525	2, 605	2, 969	4, 049	5, 129
Township 6 (Pittsburg)	41. 1	510	925	1, 013	1, 377	2, 457	2, 821	3, 901	4, 981
Township 7 (El Cerrito)	8. 0	3, 077	3, 550	3, 914	4, 994	6, 074	6, 438	7, 518	8, 598
Township 8 (Antioch)	34. 2	362	474	562	926	1, 290	1, 378	1, 742	2, 822
Township 9 (Brentwood)	53. 3	76	119	122	210	298	325	688	1, 052
Township 10 (El Sobrante)	38. 2	775	791	879	1, 243	1, 607	1, 971	3, 051	4, 131
Township 11 (Pinole)	23. 1	334	446	534	898	1, 262	1, 626	1, 990	3, 070
Township 12 (Crockett)	3. 5	1, 313	1, 361	1, 387	1, 751	2, 115	2, 203	2, 567	3, 647
Township 13 (Mount Diablo)	56. 6	11	4	7	10	36	39	65	91
Township 14 (Byron)	76. 2	18	17	43	131	220	308	672	1, 036
Township 15 (Richmond)	13. 2	7, 541	7, 576	7, 940	9, 020	10, 100	10, 464	11, 544	12, 624
Township 16 (Port Chicago)	11. 1	296	253	279	643	731	819	1, 899	2, 263
Township 17 (Oakley)	79. 7	64	102	128	216	580	669	1, 032	1, 396
Marin:									
Novato	178. 3	51	144	232	321	409	497	861	1, 225
San Rafael	78. 3	619	1, 043	1, 131	1, 495	1, 859	2, 223	3, 303	4, 383
Sausalito	76. 5	342	532	620	984	1, 348	1, 436	1, 800	2, 164
Tomales	188. 1	11	14	17	43	131	157	246	334
Napa:									
Calistoga	55. 5	45	47	50	53	79	105	193	281
Napa	494. 4	74	110	136	224	313	401	765	1, 129
St. Helena	239. 5	32	43	46	49	140	163	251	340
San Francisco:									
San Francisco	44. 6	17, 385	17, 783	18, 863	19, 943	21, 023	22, 103	22, 467	22, 831
San Mateo:									
Township 1 (South San Francisco)	63. 8	1, 069	2, 404	2, 768	3, 848	4, 928	5, 292	6, 372	7, 452
Township 2 (Belmont)	68. 0	1, 001	1, 765	2, 129	3, 209	4, 289	4, 653	5, 733	6, 813
Township 3 (Redwood City)	145. 6	481	936	1, 024	1, 388	1, 752	1, 840	2, 920	4, 000
Township 4 (Half Moon Bay)	171. 3	23	25	51	77	166	254	618	981
Township 5 (Burlingame)	6. 1	4, 147	4, 641	5, 004	6, 085	7, 165	7, 529	8, 609	9, 689
Santa Clara:									
Burnett	225. 4	25	33	59	147	236	323	687	1, 051
Campbell	7. 6	1, 220	2, 750	3, 114	3, 478	4, 558	4, 922	6, 002	7, 082
Fremont	66. 2	405	1, 287	1, 651	2, 015	2, 378	2, 742	3, 822	4, 902
Gilroy	354. 5	34	64	152	241	329	417	781	1, 145
Palo Alto	19. 6	1, 755	4, 612	5, 692	6, 772	7, 136	7, 500	8, 580	8, 944
Redwood	58. 9	305	611	699	788	1, 151	1, 240	2, 320	3, 400
San Jose	484. 8	270	485	573	937	1, 301	1, 389	1, 753	2, 117
Santa Clara	38. 9	831	2, 072	2, 436	3, 516	4, 596	4, 960	5, 324	6, 404
Saratoga	31. 5	184	776	864	1, 228	1, 592	1, 956	3, 036	4, 116
Sunnyvale	18. 2	849	3, 005	4, 085	5, 165	5, 529	5, 617	5, 981	7, 061
Solano:									
Benicia	37. 2	206	326	352	716	1, 080	1, 168	2, 249	3, 328
Denverton	61. 1	2	2	5	31	119	145	234	597
Elmira	41. 6	20	24	27	115	203	292	656	1, 019
Green Valley	45. 1	23	32	58	146	235	323	687	1, 051
Maine Prairie	83. 0	8	12	15	103	191	218	581	945
Montezuma	43. 6	7	7	33	121	485	574	937	1, 301
Rio Vista	91. 8	34	36	62	150	239	327	691	1, 055
Silveyville	90. 0	43	50	76	102	191	279	643	1, 006
Suisun	154. 2	72	107	133	221	310	398	762	1, 126
Tremont	47. 4	8	11	37	125	489	578	941	1, 305
Vacaville	98. 1	58	86	112	200	289	315	679	1, 042
Vallejo	33. 9	2, 068	2, 711	2, 799	3, 163	3, 527	3, 891	4, 971	6, 051
Sonoma:									
Analy	166. 6	78	102	128	216	305	394	757	1, 121
Cloverdale	179. 9	22	28	31	57	83	109	197	286
Healdsburg	381. 6	26	33	36	62	88	114	202	291
Petaluma	173. 5	88	132	158	246	610	699	1, 062	1, 426
Redwood	357. 5	10	13	16	19	21	24	50	76
Santa Rosa	194. 3	199	321	409	773	1, 137	1, 225	1, 589	1, 953
Sonoma	125. 4	110	206	232	320	409	497	861	1, 225

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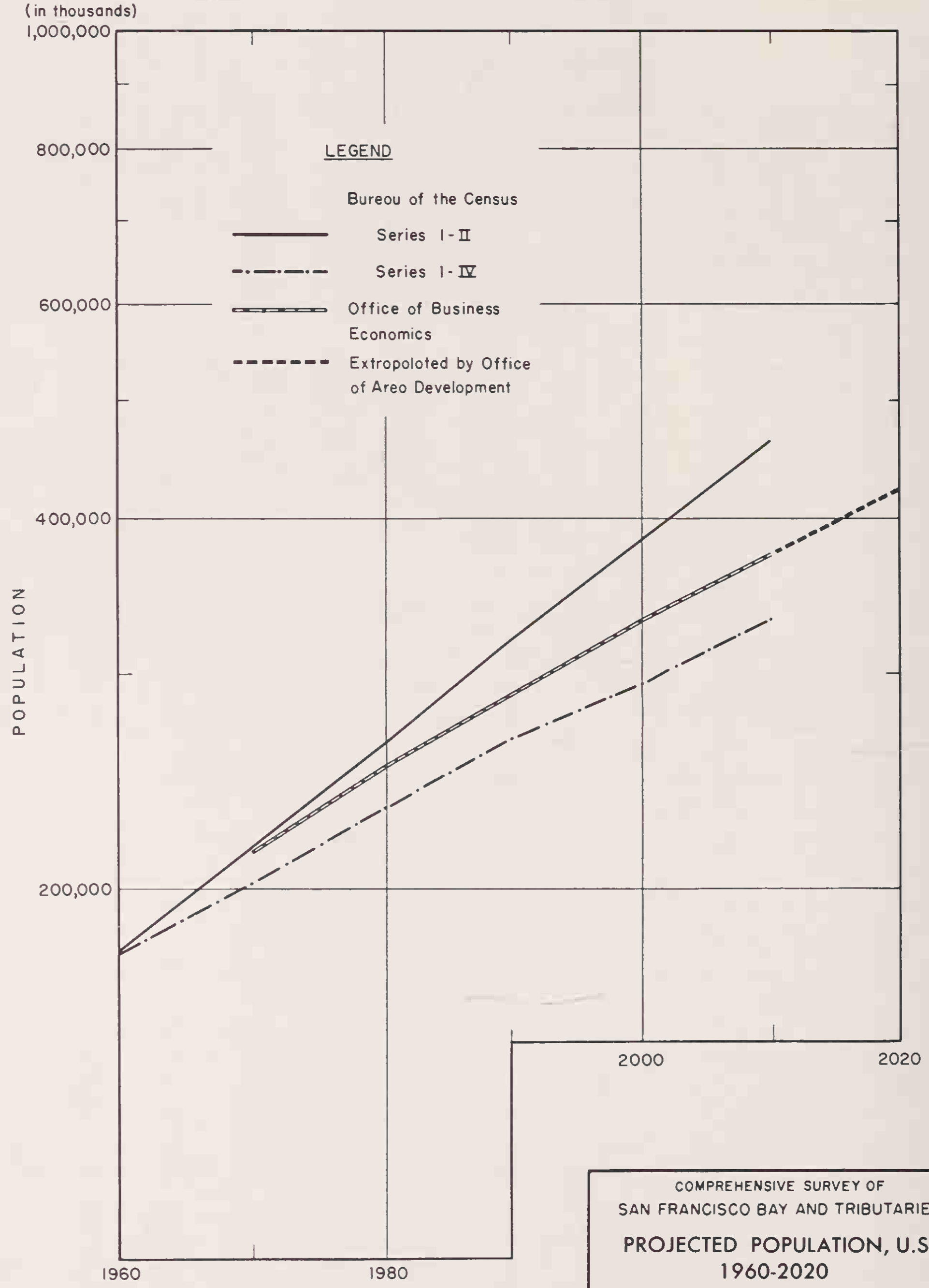
[1] Calculated densities using 1950 Population Census data.

CORPS OF ENGINEERS

U. S. ARMY

FIGURE 5



COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES

PROJECTED POPULATION, U.S.
1960-2020

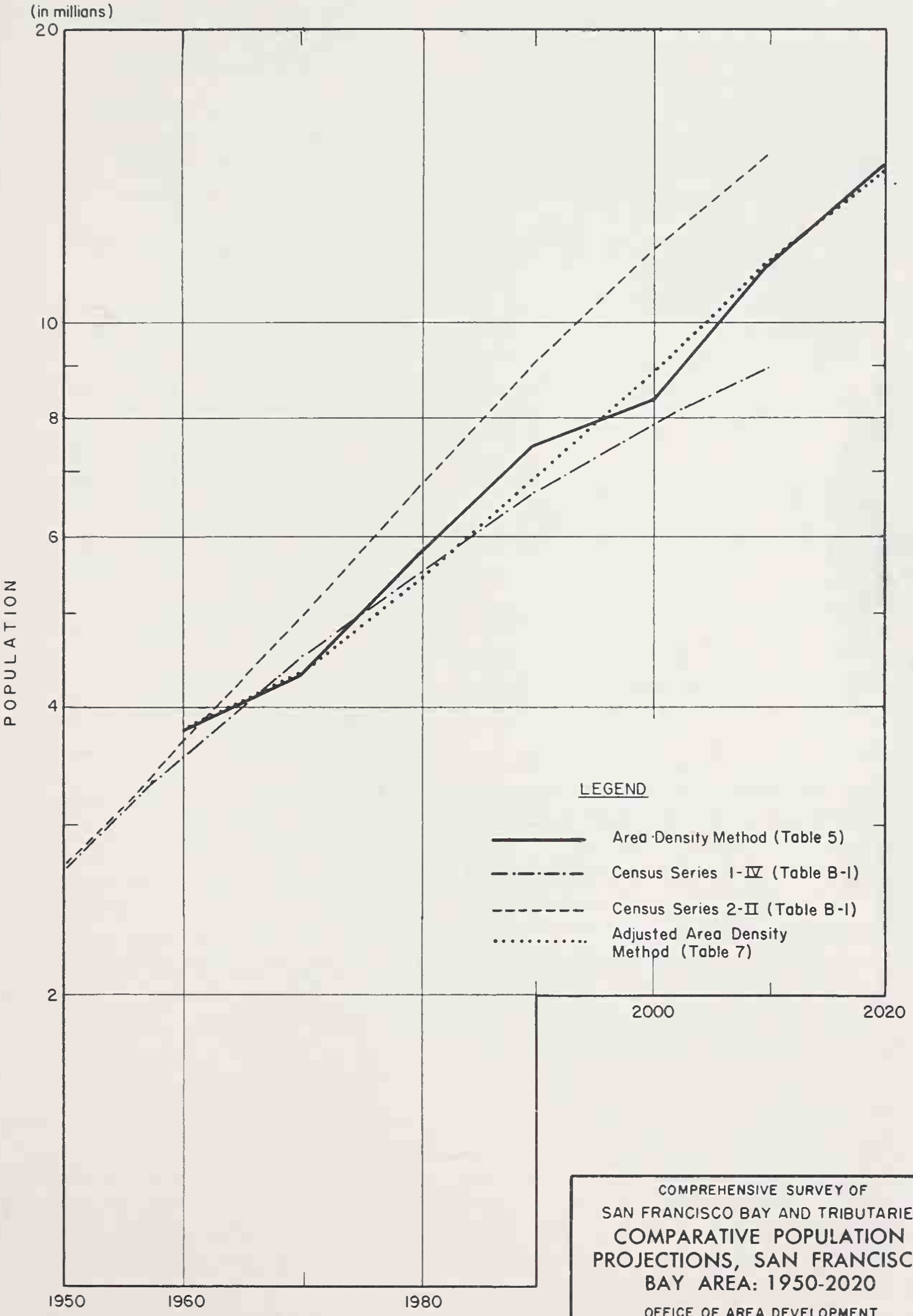
OFFICE OF AREA DEVELOPMENT
U. S. DEPARTMENT OF COMMERCE
WASHINGTON, D. C.

DRAWN JW
TRACED: JW
CHECKED: JKF

FILE NO.
TO ACCOMPANY REPORT
DATED: Dec. 1959

CORPS OF ENGINEERS U.S. ARMY

FIGURE 6



COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES

COMPARATIVE POPULATION PROJECTIONS, SAN FRANCISCO BAY AREA: 1950-2020

OFFICE OF AREA DEVELOPMENT
U.S. DEPARTMENT OF COMMERCE
WASHINGTON, D.C.

DRAWN: JW
TRACED: JW
CHECKED: JRF
FILE NO.
TO ACCOMPANY REPORT
DATED: Dec. 1959

ADJUSTED POPULATION PROJECTIONS

As previously stated, irregularities in the future growth rate of the recommended population series are, of course, attributable to anticipated cyclical movements in the economy. It is recognized, however, that many persons and organizations who might wish to use this analysis will find it more appropriate to their purpose to use a series of population projections which represent the long-term or secular trend. To this end, table 7 presents adjusted or smoothed-out projections representing the long-term trend over the entire 60-year study period.

The adjusted projections for these counties do not differ greatly from the recommended county projections except during the two periods of slower growth which characterize the first set.

> NOTE.—The population projections used throughout this report as a basis for all discussions, maps, and charts, are taken from the Area Density Population Projections in table 5.

Table 7.—Adjusted Population Projections for San Francisco Bay Area Counties: 1960–2020

[In thousands]

	1960	1970	1980	1990	2000	2010	2020
Bay Area total	3, 752	4, 270	5, 370	6, 870	8, 840	11, 420	14, 420
Alameda	954	1, 050	1, 250	1, 560	1, 940	2, 380	2, 850
Contra Costa	397	480	630	860	1, 180	1, 600	2, 120
Marin	151	180	240	320	440	600	790
Napa	67	80	120	180	280	430	660
San Francisco	793	850	900	940	980	1, 010	1, 020
San Mateo	442	460	660	840	1, 100	1, 400	1, 750
Santa Clara	657	820	1, 070	1, 420	1, 860	2, 380	2, 950
Solano	141	160	220	330	450	760	1, 120
Sonoma	150	190	280	420	610	860	1, 160

HIGHLIGHTS OF FUTURE POPULATION GROWTH AND DISTRIBUTION

25. Purpose

This section will describe, on the basis of the recommended population projections, how much, how fast, where, and why the San Francisco Bay Area and civil divisions within the Bay Area are expected to grow from 1960 to 2020.

The recommended population projections for the Bay Area, its counties and townships by decades from 1960 to 2020, appear in table 5. In addition, population distribution maps for each decade from 1960 to 2020 are contained in the plate supplement.

26. Bay Area Growth

Figure 1 shows graphically that population in the San Francisco Bay Area is expected to grow from an estimated 3.8 million in 1960 to 7.4 million in 1990, reaching 14.4 million by 2020. From 1960 to 1990, Bay Area population is expected to almost double, and by 2020 Bay Area population will nearly have quadrupled its 1960 population. From decade to decade Bay Area population will increase as follows:

	Millions
1960–70	0.56
1970–80	1.42
1980–90	1.70
1990–2000	0.84
2000–10	3.00
2010–20	3.15

The differences in population growth increments for the Bay Area from decade to decade as indicated by figure 7 result from the assumption that, between now and 2020, the economy will describe two cycles (for discussion of this assumption, see p. 16). The relatively high increments of population growth shown for the latter two decades result from the fact that, as an area becomes more populous, the birth rate rises.

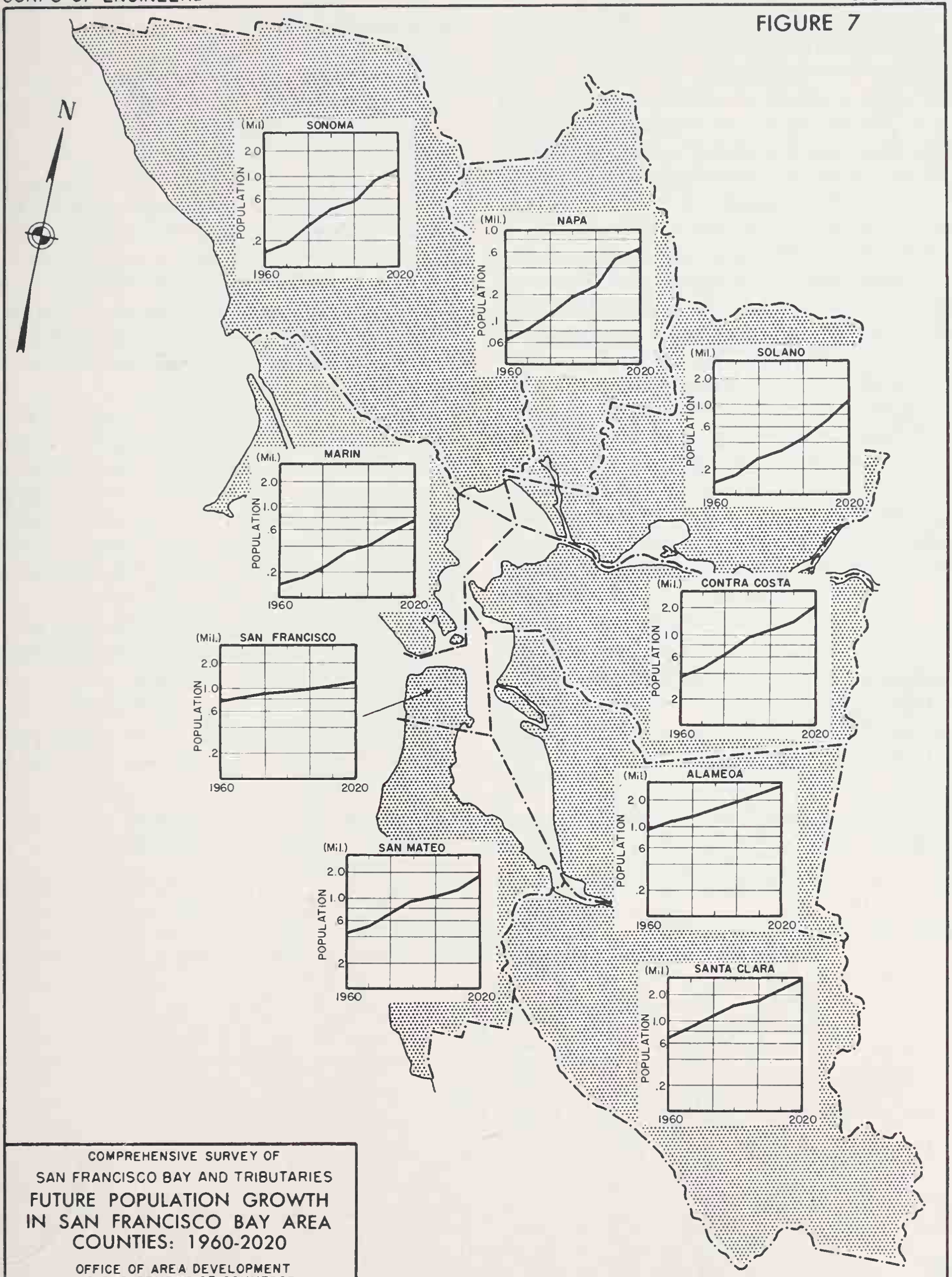
27. South Bay vs. North Bay Growth

Table 8 summarizes future population and density changes projected for 1960–1990–2020 for San Francisco County, the South Bay counties and North Bay counties. (See also pp. 24–25.) Figure 7 presents a comparative graphic analysis of the projected future growth of the Bay Area counties from 1960 to 2020.

(*a*) *San Francisco County.*—San Francisco County is expected to show the least growth of all Bay Area counties during the period 1960–2020,

CORPS OF ENGINEERS U.S. ARMY

FIGURE 7


N
(Mil) SONOMA
POPULATION
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(Mil.) MARIN
POPULATION
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POPULATION
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(Mil.) SAN MATEO
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2020
(Mil) SANTA CLARA
POPULATION
2.0
1.0
.6
.2
1960
2020

COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES

FUTURE POPULATION GROWTH IN SAN FRANCISCO BAY AREA COUNTIES: 1960-2020

OFFICE OF AREA DEVELOPMENT
U.S. DEPARTMENT OF COMMERCE
WASHINGTON, D.C.

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CHECKED: JRF DATED: Dec 1959

increasing from 793,000 in 1960 to 938,000 in 1990 and reaching 1,018,000 by 2020. On the basis of these projections, the 21-percent share San Francisco County will have of total Bay Area population in 1960 may be expected to decline to a 13-percent share in 1990 and to a 7-percent share by 2020.

Population densities of San Francisco County will not increase substantially from the estimated 1960 density of 17,800. In 1990 the projected density for the county is estimated at 21,000, increasing to 22,800 by 2020. These low projected population and density increases are based on the limited land available for development. However, it is believed the comparatively small increases in population and density in San Francisco County over the next 60 years will result from the development of higher density housing near the center of the city.

(*b*) *South Bay counties* (*exclusive of San Francisco*).—From 1960 to 1990, population in the South Bay counties of Alameda, Contra Costa, San Mateo, and Santa Clara are expected to more than double from 2.4 million to 5.1 million, an increase of 2.7 million. It is estimated that, from 1990 to 2020, the South Bay counties will increase from 5.1 million to nearly 10 million, almost a twofold increase. Over the projection period, South Bay counties are expected to increase their share of total Bay Area population from 65 percent in 1960 to 69 percent by 1990, leveling off to a 67-percentage share of Bay Area population by 2020.

Population densities of the South Bay counties are expected to double from an average South Bay density of nearly 800 persons per square mile in 1960 to almost 1,600 in 1990. By 2020 the South Bay density will be 3,000 persons per square mile, or nearly four times the 1960 density.

These projections reflect the strong economic potential of the South Bay Area for future growth. The South Bay counties offer ample land for anticipated industrial and residential development (see pp. 55–56, ch. IV); moreover, it is expected that the southward growth along the San Francisco-Los Angeles axis will serve increasingly as a stimulus to rapid development of the extreme southern and southeastern portions of the study area and the areas immediately beyond its borders.

Through 1970, major growth in the South Bay counties will be in San Mateo County, northern Santa Clara County, and western Alameda County. The eastern parts of Alameda, Contra Costa, and Santa Clara Counties are too rugged, too isolated, and lack sufficient transportation and communication facilities to attract enough people to occupy land at high densities in the near future.

The decade 1980–90 is expected to be marked by a shift in the direction of new population growth. There are anticipated increasing urban development in Contra Costa County and suburban development in the Livermore Valley of Alameda County, in Contra Costa County, and along the

Table 8.—Summary of Population and Density Changes, San Francisco Bay Area: 1960–1990–2020

Area	1960			1990			2020		
	Population	Percent of Bay Area	Density (persons per square mile)	Population	Percent of Bay Area	Density (persons per square mile)	Population	Percent of Bay Area	Density (persons per square mile)
	Thousands			*Thousands*			*Thousands*		
Bay Area total	3, 752	100. 0	537	7, 425	100. 0	1, 062	14, 410	100. 0	2, 062
San Francisco County	793	21. 1	17, 780	938	12. 6	21, 031	1, 018	7. 1	22, 825
South Bay Counties total	2, 448	65. 3	758	5, 099	68. 7	1, 580	9, 674	67. 1	2, 951
Alameda	954	25. 4	1, 301	1, 673	22. 5	2, 281	2, 854	19. 8	3, 891
Contra Costa	396	10. 6	540	961	13. 0	1, 310	2, 140	14. 9	2, 916
San Mateo	441	11. 8	970	933	12. 6	2, 051	1, 749	12. 1	3, 846
Santa Clara	657	17. 5	503	1, 532	20. 6	1, 173	2, 931	20. 3	2, 245
North Bay Counties total	511	13. 6	137	1, 388	18. 7	373	3, 718	25. 8	1, 000
Marin	152	4. 0	292	347	4. 7	666	790	5. 5	1, 516
Napa	67	1. 8	85	193	2. 6	244	655	4. 6	830
Solano	141	3. 8	170	362	4. 9	438	1, 116	7. 7	1, 349
Sonoma	151	4. 0	96	486	6. 5	308	1, 157	8. 0	733

shores of Suisun Bay. In the period 2000–2020, there will be additional suburban development in southern Santa Clara County and the eastern parts of Alameda and Contra Costa Counties.

(*c*) *North Bay counties.*—From 1960 to 1990, the North Bay counties will increase from 0.5 million to 1.4 million—an increase of 0.9 million. North Bay population will increase further from 1.4 million in 1990 to 3.7 million in 2020. In 2020, 26 percent of the total Bay Area population will live in the North Bay counties as compared to 19 percent in 1990 and 14 percent in 1960. North Bay population densities, based on these projections, will increase from over 100 persons per square mile in 1960 to nearly 400 in 1990 and to 1,000 in 2020.

The four North Bay counties have shared in the Bay Area's growth in the past. This growth has occurred mainly in the habitable flatlands along the perimeter of the San Francisco Bay system and paralleling the Sacramento River.

Southern Marin County is most accessible to the Bay Area's economic core. Because of this, and its physical attractiveness, southern Marin has virtually become a dormitory for San Francisco. If local interests are successful in their purpose, the present character of development will be maintained indefinitely. By reason of this county's location, Marin's future growth should continue to be closely related to developments in nearby areas of South Bay counties.

Napa and Sonoma Counties, on the other hand, are and should continue to be less directly associated with South Bay developments. This is particularly true of the central and extreme northern portions of these counties. Solano is unique among the nine counties because it is economically oriented both to the Bay Area (in the southern portion of the county) and to the Central Valley (in the southeastern part of the county).

Significant future growth of Marin, Napa, and Sonoma Counties is most likely to be concentrated in the southern portions bordering the Bay. For a considerable part of the study period, the character of this growth is likely to be predominantly, but not exclusively, suburban. As the southern reaches of Marin County and the northern East Bay residential areas become more crowded, the Bay Area's expanding population will find the lower portions of Sonoma and Napa Counties increasingly attractive for residential development.

By reason of its proximity to both the Bay Area economic core and the Central Valley, the southeastern half of Solano County should become increasingly attractive to heavy industries in search of unrestricted sites served by navigable waterways. Nevertheless, intensive development of this type is not anticipated for a decade or two because ample unrestricted land is still available in the more highly developed southern counties and near expanding Central Valley communities to the east of the Bay Area.

(*d*) *Changes in population rank.*—It is expected that, in 1960, 3.2 million, or 86 percent, of the total Bay Area population will be concentrated in San Francisco County and the South Bay counties and only 0.5 million or 14 percent in the North Bay counties. By 1960 there will be 6 million, or 81 percent, in San Francisco and the South Bay counties and 1.4 million, or 19 percent, in the North Bay counties. By 2020 there will be 10.7 million, or 74 percent, in San Francisco and the South Bay counties and 3.7 million, or 26 percent, in the North Bay counties.

By 1990 and 2020 the counties will be ranked in population as shown in table 9.

Table 9.—Rank in Population of North and South Bay Counties
San Francisco Bay Area: 1960–1990–2020

[In thousands]

Rank in 1960		*Rank in 1990*		*Rank in 2020*	
South Bay	3,241	South Bay	6,037	South Bay	10,692
Alameda	954	Alameda	1,673	Santa Clara	2,931
San Francisco	793	Santa Clara	1,532	Alameda	2,854
Santa Clara	657	Contra Costa	961	Contra Costa	2,140
San Mateo	441	San Francisco	938	San Mateo	1,749
Contra Costa	396	San Mateo	933	San Francisco	1,018
North Bay	511	North Bay	1,388	North Bay	3,718
Marin	152	Sonoma	486	Sonoma	1,157
Sonoma	151	Solano	362	Solano	1,116
Solano	141	Marin	347	Marin	790
Napa	67	Napa	193	Napa	655

Table 10.—Comparison of 1950 Densities and 2020 Projected Densities of 10 San Francisco Bay Area Townships With 1950 Densities in Selected Townships in Other U.S. Cities

Bay Area township	Selected other townships	Population density		1940 area in square miles
		1950	2020	
Alameda		9, 922	15, 355	6. 5
	Bayonne, N.J	17, 546		4. 4
	Paterson, N.J	17, 202		8. 1
	Galveston, Tex	8, 218		8. 1
Oakland-Peralta		24, 185	30, 062	13. 8
	Bronx, N.Y	35, 397		41. 0
	Jersey City, N.J	20, 910		14. 3
San Francisco		17, 230	22, 831	44. 6
	Bronx, N.Y	35, 397		41. 0
	Boston, Mass	17, 385		46. 1
Township 15 (Richmond)		7, 541	12, 624	13. 2
	Malden, Mass	12, 459		4. 8
	Alexandria, Va	7, 723		8. 0
	Bridgeport, Conn	10, 870		14. 6
	Wilmington, Del	11, 260		9. 8
Township 7 (El Cerrito)		3, 077	8, 598	8. 0
	Santa Monica, Calif	8, 949		8. 0
	Brookline, Mass	8, 469		6. 8
	Alexandria, Va	7, 723		8. 0
	Medford, Mass	8, 162		8. 1
Brooklyn		3, 690	9, 033	52. 8
	Evanston, Ill	8, 980		8. 2
	Richmond, N.Y	3, 360		57. 0
Campbell		1, 220	7, 082	7. 6
	Medford, Mass	8, 162		8. 1
	Brookline, Mass	8, 469		6. 0
	Montclair, N.J	7, 085		6. 2
	Plainfield, N.J	7, 061		6. 0
	Compton, Calif	6, 955		6. 9
Palo Alto		1, 755	8, 944	19. 6
	Elizabeth, N.J	9, 642		11. 7
	Yonkers, N.Y	8, 883		17. 2
	Bethesda, Md	2, 121		21. 6
	Waukegan, Ill	2, 598		19. 8
	Stratford, Conn	1, 807		18. 5
Sunnyvale		849	7, 061	18. 2
	Yonkers, N.Y	8, 883		17. 2
	Harrison, N.Y	771		17. 6
Township 5 (Burlingame)		4, 147	9, 689	6. 1
	Brookline, Mass	8, 469		6. 8
	Evanston, Ill	8, 980		8. 2
	Elizabeth, N.J	9, 642		11. 7
	White Plains, N.Y	4, 624		9. 4

COMPARISON ANALYSIS OF PROJECTED BAY AREA DENSITIES

An indication of whether or not population densities and rates of population density increase projected by the Area Density Method for townships in the San Francisco Bay Area are reasonable may be obtained by comparing them with population densities of generally comparable areas elsewhere in the country.

(*a*) *Selection of areas for test purposes.*—The selection of townships in other parts of the United States for comparison with San Francisco Bay Area townships involved examination of nine metropolitan areas possessing characteristics considered most pertinent to the present analysis: Los Angeles, Calif., Washington, D.C., Philadelphia, Pa., Wilmington, Del., Chicago, Ill., Boston, Mass., New York, N.Y., Houston, Tex., and Kansas City, Mo. The townships included for comparison with Bay Area townships were selected on the basis of such comparable characteristics as primary township function (industrial, suburban), location of townships in relation to metropolitan area (central or outlying), and population size.

(*b*) *Comparisons of density.*—Population densities projected for the period 1960–2020, at 10-year intervals, for the 66 townships in the San Francisco Bay Area, appear in table 6. Reasonableness of these projected densities for the Bay Area was spot-checked by comparing the 1950 and projected 2020 densities of 10 San Francisco Bay Area townships with urban and suburban densities of more mature areas elsewhere in the United States. (See table 10.)

(*c*) *Selected findings of population density comparisons.*—In reviewing table 10, the higher population densities projected for Bay Area townships in 2020 are found to be considerably lower than the actual 1950 densities of a number of other areas. For example, the projected 2020 population densities for Oakland-Peralta (30,100) and San Francisco (22,800) are still measurably less than the 1950 density for Bronx, N.Y. (35,400). Considering another Bay Area township, Campbell, with a projected 2020 population density of 7,100, comparison indicates 5 other townships, all approximately the size of the Bay Area community, which in 1950 had densities not much different from that projected for Campbell in 2020.

Chapter III. Employment and Economic Growth

INTRODUCTION

This chapter describes the basis for projecting the character and size of the San Francisco Bay Area economy in terms of employment levels expected during the period 1960–2020. Rates of past growth of population and industry for the Bay Area, California, the Western States, and the Nation are compared in search of criteria for establishing probable future trends in the Bay Area economy. The major employment divisions of the local economy are examined to ascertain their relative importance and the contribution of each toward growth of the Bay Area and to select rates for projecting future growth. Projections of employment and the procedures followed in developing these projections are presented, with special emphasis on prospects for growth of manufacturing which will be an important element in shaping future growth of the San Francisco Bay Area economy.

28. Comparison of National, Regional, and Local Growth Trends

To a degree, population growth and shifts within the United States indicate concurrent economic developments. There follows a comparison of recent population growth trends in the San Francisco Bay Area and those of California, the West, and the Nation.

In July 1957, the population of the continental United States was estimated to be about 170 million. This is almost 4½ times the population of almost 40 million in 1870 and more than twice the population at the beginning of this century. During the period from 1870 to 1957, the total population of the 11 Western States increased from slightly less than a million persons to nearly 25 million persons, and the population in the State of California increased 37-fold, from a little over one-third of a million persons to over 14 million persons. In 1957, the San Francisco Bay Area population was 13 times as large as it was in 1870, having increased from 266,000 in the earlier year to an estimated 3,350,000. Thus, the San Francisco Bay Area, which has not grown as fast as the West or the State of California, has increased its population substantially faster than the United States as a whole. (See fig. 8.)

Moreover, the rate of population growth of the Bay Area has exceeded the rate of growth of the United States in every decade except 1890–1900, during which time the rates were about the same. During the most recent decade of rapid growth, 1940–50, nearly one out of every three persons added to the population of the United States was added in the West. Nearly 1 out of every 5 was added in California, and 1 out of 20 was in the Bay Area. Although these ratios for the western areas have dropped since the record wartime high, the recent increases are higher than in any decade prior to 1940.

Table 11 shows the population growth which occurred in two periods, 1940–50 and 1950–58, in the San Francisco Bay Area and in selected areas elsewhere in the Nation. From this table, it is evident that population growth in the Bay Area has been substantially greater than that for the Nation, the aggregate of all Standard Metropolitan Areas, and for the 11 Western States.

The actual growth rates for several of these selected areas are shown graphically in figure 9, from which the following comparisons were drawn:

Geographical area	Rate of population growth in relation to San Francisco Bay Area	
	1940–50	1950–58
U.S. total	Slower	Slower.
All Standard Metropolitan Areas.	do	Do.
Standard Metropolitan Areas with more than 3,000,000 (1958).	do	Do.
Standard Metropolitan Areas with from 800,000 to 3,000,000 (1958).	do	Do.
11 Western States	do	About same.
California	Faster	Do.
Los Angeles	About same	Faster.

Table 11.—Comparative Population and Growth Rates for United States, Selected California Areas, and Metropolitan Area Aggregates

	Population (in thousands)			Annual average percentage change	
	January 1958	April 1950	April 1940	1950–58	1940–50
U.S. total	171, 994. 4	150, 697. 4	131, 669. 3	1. 8	1. 4
San Francisco Bay Area	3, 431. 8	2, 681. 3	1, 734. 3	3. 6	5. 5
Sonoma County	139. 5	103. 4	69. 1	4. 5	5. 0
Napa County	64. 9	46. 6	28. 5	5. 1	6. 4
San Francisco-Oakland and San Jose Standard Metropolitan Areas	3, 227. 4	2, 531. 3	1, 636. 7	3. 5	5. 5
San Francisco-Oakland Standard Metropolitan Area	2, 701. 9	2, 240. 8	1, 461. 8	2. 7	5. 3
San Jose Standard Metropolitan Area	525. 5	290. 5	174. 9	10. 4	6. 6
Los Angeles area	6, 820. 9	4, 819. 5	3, 183. 0	5. 4	5. 1
Riverside County	265. 2	170. 0	105. 5	7. 2	6. 1
San Bernardino County	446. 6	281. 6	161. 1	7. 6	7. 5
Los Angeles Standard Metropolitan Area	6, 109. 1	4, 367. 9	2, 916. 4	5. 1	5. 0
Northern California [1]	5, 657. 3	4, 428. 5	2, 916. 8	3. 6	5. 2
Southern California [2]	8, 623. 1	6, 139. 7	3, 990. 6	5. 2	5. 4
California	14, 280. 4	10, 568. 2	6, 907. 4	4. 5	5. 3
Pacific Coast States	18, 831. 4	14, 486. 5	9, 733. 3	3. 9	4. 9
11 Western States	25, 225. 7	19, 561. 5	13, 883. 3	3. 7	4. 1
U.S. urban	....	[3] 96, 467. 4	74, 423. 7	....	2. 0
All Standard Metropolitan Areas (on constant 1950 basis) [4]	103, 940. 8	84, 989. 6	69, 626. 2	2. 9	2. 2
All Standard Metropolitan Areas (including increase in number) [4]	115, 643. 7	84, 989. 6	69, 626. 2	....	....
Standard Metropolitan Areas with more than 3,000,000 (1958)	34, 897. 4	29, 462. 4	24, 979. 6	2. 4	1. 8
Standard Metropolitan Areas from 800,000 to 3,000,000 (19 cities) (1958) [4]	28, 295. 1	23, 450. 9	18, 692. 3	2. 7	2. 6

[1] San Francisco tributary area: all counties north of and including Fresno and Monterey, excluding Mono and Inyo.

[2] Los Angeles tributary area: all counties south of and excluding Fresno and Monterey, including Mono and Inyo.

[3] New definition; 1950 figure comparable to 1940 is 88,927,500, representing a 2-percent growth rate.

[4] Boston SMA defined as Essex, Middlesex, Norfolk, Suffolk Counties.

Table 12 compares, for the 25 leading Standard Metropolitan Areas in 1940, 1950, and 1958, the population in these three years and the percent change in population in the periods 1940–50 and 1950–58.

29. Economic Growth

The foregoing indicators of rapid growth of population in the Pacific Coast States, especially California, can be augmented and supported by comparative measures more directly related to economic and industrial growth.

For instance, from 1939 to 1957 the three Pacific Coast States share of total U.S. manufacturing employment advanced from 5.5 to 9.5 percent; their share of U.S. "value added by manufacture" [3] rose from 6.3 to 10.2 percent; and their portion of "new capital expenditures," 6.5 percent in 1939, by 1957 was 10 percent of the U.S. total (154).

Because of the tendency of "new capital expenditures" to fluctuate rather sharply from year to year and region to region, comparison based upon cumulative values actually is more meaningful than comparison based on any two points in time. Thus, for the 6-year period 1951–57, the Pacific Coast States share of cumulative "new capital expenditures" was almost 10 percent of the U.S. total. Of this amount, California's share was almost 71 percent.

In 1940, the Pacific Coast States had 9.8 percent of the U.S. total personal income; by 1958, according to the Survey of Current Business (August 1959), their share had risen to almost 13 percent—an increase of 33 percent in the proportional share. This rate of change exceeded the rates of all other regions except the eight Mountain States. For the Mountain States, the 1940–58 percent of increase in their share of U.S. total personal income also was 33 percent. During this

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[3] "Value added by manufacture" represents value of products shipped by manufacturing plants, less their cost of materials, supplies, fuels, electrical energy, and contract work.

Table 12.—Population of Leading Standard Metropolitan Areas: 1940, 1950, 1958

Standard Metropolitan Area	Population (in thousands)			Percent change	
	1958	1950	1940	1950–58	1940–50
New York	14, 330	12, 912	11, 661	11. 0	10. 7
Chicago	6, 266	5, 495	4, 826	14. 0	13. 9
Los Angeles-Long Beach	6, 109	4, 368	2, 916	39. 9	49. 8
Philadelphia	4, 349	3, 671	3, 200	18. 5	14. 7
Detroit	3, 843	3, 016	2, 377	27. 4	26. 9
San Francisco-Oakland	2, 702	2, 241	1, 462	20. 9	53. 3
San Francisco-Oakland-San Jose	3, 227	2, 531	1, 637	27. 5	54. 6
Boston [1]	3, 003	2, 876	2, 656	4. 4	8. 3
Pittsburgh	2, 408	2, 213	2, 083	8. 8	6. 2
St. Louis	1, 965	1, 681	1, 432	16. 9	17. 4
Washington, D.C	1, 915	1, 464	968	30. 8	51. 2
Cleveland	1, 720	1, 466	1, 267	17. 3	15. 7
Baltimore	1, 577	1, 337	1, 083	18. 0	23. 5
Minneapolis-St. Paul	1, 329	1, 117	941	19. 0	18. 7
Buffalo	1, 304	1, 089	958	19. 7	13. 7
Houston	1, 180	807	529	46. 2	52. 6
Milwaukee	1, 157	871	767	20. 9	13. 6
Cincinnati	1, 057	904	787	16. 9	14. 9
Kansas City	1, 009	814	687	24. 0	18. 5
San Diego	906	557	289	62. 7	92. 7
Atlanta	866	672	518	24. 6	29. 7
Seattle	860	733	505	17. 3	45. 1
Dallas	853	615	399	38. 7	54. 1
New Orleans	845	685	552	23. 4	24. 1
Portland	838	705	501	18. 9	40. 7
Miami	800	495	268	61. 6	84. 7

[1] Boston Standard Metropolitan Area defined as Essex, Middlesex, Norfolk, and Suffolk Counties.

Sources: U.S. Population Censuses, 1940 and 1950; Jan. 1, 1958 estimates published in the Sales Management "Survey of Buying Power," May 10, 1958.

period, the extent to which California dominated the income totals of the West and the Pacific Coast region was strengthened even further. Over two-thirds of the increase in the West's share of the U.S. total was attributable to California, and 2.8 of the 3.1 percentage points increase in the Pacific Coast States total, or over 90 percent, also were attributable to the same State.

From these illustrations of comparative rates of recent growth at State, regional, and national levels, it is evident that the average annual rates of increase in the Pacific Coast States share of the U.S. total manufacturing employment and of "value added by manufacture" between 1939 and 1957 have both exceeded the average annual rate of increase in the Pacific Coast States share of the U.S. population for the same period. The Pacific Coast States share of employment in manufactures has advanced at an average annual rate of 0.25 of 1 percent per year since 1939. Their share of "value added by manufacture" has advanced at a rate of 0.21 of 1 percent per year, whereas their share of total population has advanced at a rate of 0.19 of 1 percent for the same period.

The contrast in rates of population and industrial growth is even more marked if attention is confined to growth rates since 1950. During the seven years 1950–57, the Pacific Coast States share of U.S. population has advanced at a rate of 0.17 of 1 percent per year, while advances in shares of manufacturing employment and "value added by manufacture" have been 0.35 and 0.34 of 1 percent per annum, respectively, or about twice the rate of the population increase.

Review of the rates at which the Pacific Coast States are increasing their share of national population and manufacturing output suggests that, as the current tendency for equalization of population among major regions continues, and the Pacific Coast States acquire an ever-increasing share of the U.S. total, there will be an even more marked tendency for the Pacific Coast States to increase their share of the Nation's industrial output.

It appears evident from the earlier discussion that this growth will be largely an urban phenomenon. As the second-ranking metropolitan area in the West, the San Francisco Bay Area will gain a sizable share of that growth.

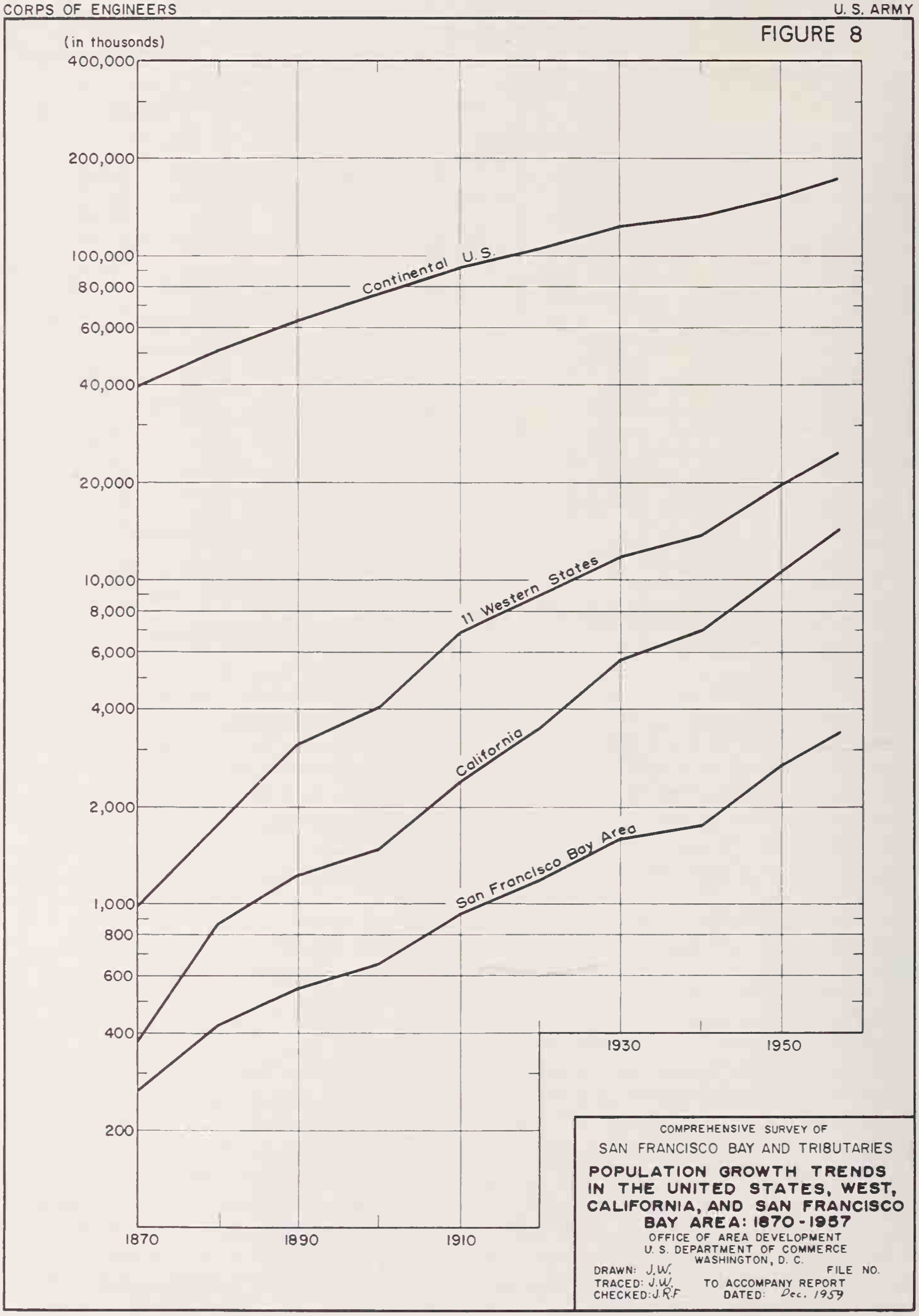


FIGURE 8

COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES

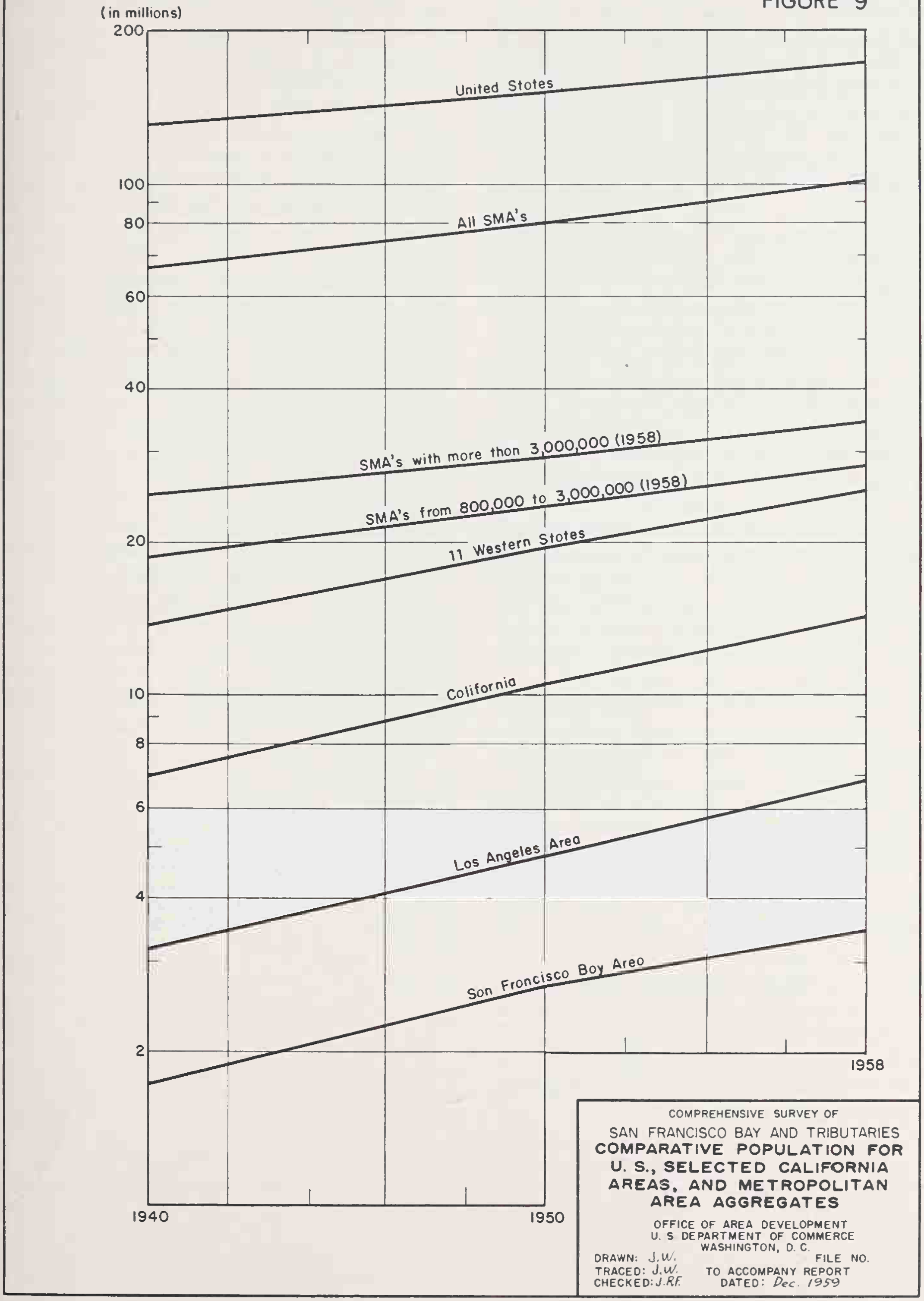
POPULATION GROWTH TRENDS IN THE UNITED STATES, WEST, CALIFORNIA, AND SAN FRANCISCO BAY AREA: 1870-1957

OFFICE OF AREA DEVELOPMENT
U. S. DEPARTMENT OF COMMERCE
WASHINGTON, D. C.

DRAWN: J.W.
TRACED: J.W.
CHECKED: J.R.F.
FILE NO.
TO ACCOMPANY REPORT
DATED: Dec. 1959

CORPS OF ENGINEERS U. S. ARMY

FIGURE 9



COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES
COMPARATIVE POPULATION FOR U. S., SELECTED CALIFORNIA AREAS, AND METROPOLITAN AREA AGGREGATES

OFFICE OF AREA DEVELOPMENT
U. S DEPARTMENT OF COMMERCE
WASHINGTON, D. C.

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CHECKED: J.R.F. DATED: Dec. 1959

30. Specific Factors Encouraging Continuing Economic Growth

It is reasonable to assume that the Bay Area's share of the national wealth and well-being will continue to increase during future years. This assumption is amply supported by the area's past performance and its economic growth potential. Moreover, the assumption implicitly underlies future population growth of the magnitude shown in chapter II.

For example, at the national level, the assumption has been made by the Office of Business Economics, U.S. Department of Commerce, that the gross national product will increase in the next 50 years at about the same rate that it has increased during the past 50 years, and that, based on an estimated population of 370 million for the United States in 2010, the gross national product will exceed $2,300 billion per annum (159). Carrying this rate of population growth forward another decade, the gross national product could, by 2020, reach the order of $3,000 billion in 1957 dollars.

A per capita increase in national income of this magnitude implies that disposable per capita income may well become substantially greater than it is at present. More disposable per capita income, coupled with a probable decline in length of the average workweek, have important implications regarding the future San Francisco Bay Area economy.

Local factors that should continue to encourage economic growth include the central location of the Bay Area on the West Coast, the Bay Area's status as a major ocean port, and its established position as a financial, communications, and distribution center. As a consequence, the Bay area not only should continue as a major regional supply center for its growing consumer and industrial markets, but also should benefit as a focal point for increased trade with hitherto underdeveloped countries in the Pacific Basin and South America.

Still another reason for optimism about the future economic growth of the Bay Area is San Francisco's primary hinterland, which includes some of the richest (if not the most extensive) agricultural land in America—the Sacramento Valley and most of the San Joaquin Valley.

The natural beauty of the Bay Area and its cultural heritage and entertainment facilities have proven to be prime tourist attractions. When these assets are considered in the national context of rising disposable incomes and increased leisure time, the outlook favors an appreciable increase in the Bay Area's important tourist business.

RECENT GROWTH OF EMPLOYMENT IN THE SAN FRANCISCO BAY AREA

31. Sources of Support for the San Francisco Bay Area Economic Base

In order to assess the relative importance of the various activities which support the San Francisco Bay Area, and thereby provide a basis for determining which aspects of the economic spectrum need most critical review in terms of potential contributions to future growth, the employment pattern of the Bay Area has been compared with other cities by means of a newly developed technique—the "minimum requirements" method—which is explained below.[4] This method, in addition to pinpointing the distinctive features of the metropolitan area's employment and economy, establishes in a specific, quantitative manner the relative contribution of the various economic divisions (manufacturing, trade, construction, etc.) in supporting the city by providing basic or export employment, as opposed to local or service employment.

"Outside market" employment refers to that portion of the employment in the several economic divisions that may be said to exist to supply goods or services for markets outside the San Francisco Bay Area. "Local market" employment refers to the remainder of employment in each of the several economic divisions that provides goods and services to the local (or San Francisco Bay Area) market. An economic division that markets (exports) a large proportion of its products (or services) outside the San Francisco Bay Area is a basic industry because it brings income into the Bay Area from outside sources. In contrast, an economic division (or industry) that exists primarily to supply or service the San Francisco Bay Area population is a nonbasic or local-service industry. Obviously, the distribution of employment between these two categories varies from one city or metropolitan area to another and, within cities, from one economic division to another. An ability to determine the balance between "basic" and "service" employment is helpful in predicting the future population and economy of the Bay Area.

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[4] This method, termed the "minimum requirements" method, was developed and adapted especially for this study by Prof. Edward L. Ullman, University of Washington. It resembles closely that developed by the Swedish economic geographer, Gunnar Alexandersson, in "The Industrial Structure of American Cities" (Stockholm, Almquist & Wiksell; Lincoln, University of Nebraska Press, 1956), although the technique was conceived and the basic work done independently before Alexandersson's book appeared. Apparently the first use of the minimum method was bv Dutch scholars cited by Alexandersson—L. H. Klassen, D. H. van Dongen Torman, and L. M. Koyck, "Hoodflijnen van de sociaal-economische ontwikkeling der gemeente Amersfoort van 1900–1970" (Leiden, 1949). Irving Morrisett, of Purdue University, also presented a paper building on the method at the Regional Science Meetings in Philadelphia, December 1957.

Earlier literature on the basic-service or export-local concept is voluminous following Homer Hoyt's pioneer efforts; some of this is compared, and the variation of the ratio according to city size noted for the first time, by Edward L. Ullman in "The Basic Service Ratio and the Areal Support of Cities," paper read to the Annual Meeting of the American Institute of Planners, San Francisco, June 1953, and reproduced in "Proceedings, Western Committee on Regional Economic Analysis of the Social Science Research Council" (Berkeley, University of California, June 25–27, 1953, David A. Revzan and Ernest A. Englebert, editors), pp. 110–23; abstract also published in Yearbook, Association of Pacific Coast Geographers, vol. 15, 1953 (Cheney, Wash.), pp. 47–48.

The "minimum requirements" method is used to estimate the "outside market" employment by establishing a procedure for determining the "local market" employment. Collaterally, it also exploits the proposition that, as cities increase in size, they become less dependent upon other areas, and local demands for goods and services absorb an increasing share of total local area employment. The procedure assumes that, for any urban area in a given size class, the minimum local area employment demand for goods and services is the equivalent of the lowest percentage that occurs in the percentage distribution profiles of all urban areas of that size class.

As will be noted below, the minimum percentage values for each of several divisions of the economy (trade, manufacturing, etc.) among all cities of a given size class (e.g., those over 1 million population) are determined. It is further assumed that the sum of these minimums represents the minimum requirements of the local population for a share in the goods and services provided by the total local employment force. The difference between these minimums and the actual employment for a given urban area is the "outside market" employment. This applies to the minimums for each economic division as well as to the total of the minimums for all economic divisions. Therefore, the method is called the "minimum requirements" method of determining, indirectly, the portion of a locality's employment that can be devoted to supplying goods and services to markets outside the local area—or the "outside market" employment.

The San Francisco-Oakland Standard Metropolitan Area has been compared with the 18 Standard Metropolitan Areas in the United States containing more than 800,000 population in 1950 and over 1 million population in 1958. (See table 13.) For each of these Standard Metropolitan Areas, the percentage of labor force employed in each of 14 census categories was calculated and the minimum percent in each category among the 18 cities was entered in table 13. The minimum was purposely selected as (1) the best benchmark from which to

Table 13.—Minimum Percentage of Labor Force, in Each of 14 Industries, Employed in Cities of over 1,000,000 Population in 1958 and over 800,000 in 1950, and Percentage Employed in San Francisco in 1950

Industry	Minimum percentage employed in—		Percent of total employment	
	14 Standard Metropolitan Areas over 1,000,000 (A)	18 Standard Metropolitan Areas over 800,000 (B)	San Francisco-Oakland Standard Metropolitan Area (C)	San Francisco Bay Area (9 counties) (D)
Total	57. 4	56. 4	100. 0	100. 0
Agriculture	. 6	. 6	2. 0	3. 8
Mining	. 1	. 1	. 1	. 1
Construction	4. 6	4. 6	7. 1	7. 4
Manufacturing:				
Durable	2. 3	2. 3	9. 7	9. 4
Nondurable	4. 9	4. 9	10. 2	10. 0
Transportation, communications, and utilities	6. 6	6. 6	10. 8	10. 1
Wholesale trade	2. 1	2. 1	5. 3	5. 1
Retail trade	14. 8	14. 8	17. 6	17. 6
Finance, insurance, and real estate	3. 1	3. 1	6. 2	5. 8
Business and repair services	2. 0	2. 0	3. 3	3. 3
Personal services	4. 6	4. 2	6. 9	6. 8
Entertainment	. 8	. 8	1. 3	1. 3
Professional services	6. 9	6. 9	10. 2	10. 5
Public administration	3. 3	2. 7	8. 0	7. 5
Industry not reported	. 7	. 7	1. 3	1. 3

Source: U.S. Population Census, 1950.

measure deviation for comparison, and (2) an indicator of the minimum needs in a specific activity for a city of this size class. Thus, among the 18 cities, the lowest percentage employed in public administration was 2.7 percent (see table 13), whereas the San Francisco-Oakland area had 8 percent, a difference of 5.3 percent. This reflects primarily governmental services almost three times the minimum required for the metropolitan area alone.

The minimum percents in each of the 14 employment categories for the 18 cities were summed to produce a total of 56.4 percent. (See table 13.) The same computation for the 14 cities over 1 million gave the slightly higher total of 57.4 percent, since fewer cases were used. (See table 13, col. A.) These figures may be considered as rough indicators of the percent of the labor force required to serve the Standard Metropolitan Areas alone, since they are summations of minimums.

Table 14 demonstrates the method for estimating the portion of the employment in the 14 industry categories that is oriented to the "outside market." The "minimums" figure for the 18 largest Standard Metropolitan Areas (col. B) is subtracted from the San Francisco-Oakland percentages (col. A) to give a remainder (col. C) which, in turn, is converted to parts of 100 percent (col. D). The values in column D are percentage expressions of the relative contribution of each industry category toward the "outside market" support of the San Francisco-Oakland Standard Metropolitan Area.

Thus, on this basis, it is noted that the profile for basic employment for San Francisco-Oakland (col. D) varies substantially from its profile for total employment (col. A). Durable manufactures, for instance, increase relatively and absolutely the most, or from 9.7 percent of total employment to 17 percent of "outside market" employment. The category decreasing the most is retail trade, dropping from 17.6 to 6.4 percent. This mirrors the universal and predominantly local character of such activity, although in absolute percentage it still remains a significant part of the area's economic base.

In table 15 the same procedure is followed except that the entire San Francisco Bay region, consisting of nine counties, is analyzed. The figures are changed very little, the most significant change being in agriculture. This points up the more rural character of the three additional counties of Santa Clara (San Jose Metropolitan Area), Napa, and Sonoma, which increase the total agricultural employment from 2 to 3.8 percent and the "outside market" employment from 3.2 to 7.3 percent, reflecting heavy shipments of foodstuffs to markets outside the Bay Area.

Table 14.—Total and "Outside Market" Employment, San Francisco-Oakland Metropolitan Area (6 Counties), and Minimums (Unadjusted) "Local Market" Employment from 18 Standard Metropolitan Areas (in Percentages): 1950

Industry	Total employees: San Francisco-Oakland Standard Metropolitan Area (A)	Minimums "local market" employment in 18 Standard Metropolitan Areas over 800,000 population (B)	"Outside market" employment: San Francisco-Oakland area	
			Col. A minus Col. B (C)	Col. C converted to parts of 100 percent (D)
Total	100.0	56.4	43.6	100.0
Agriculture	2.0	.6	1.4	3.2
Mining	.1	.1	0.0	0.0
Construction	7.1	4.6	2.5	5.7
Manufacturing:				
Durable	9.7	2.3	7.4	17.0
Nondurable	10.2	4.9	5.3	12.2
Transportation, communications, and utilities	10.8	6.6	4.2	9.6
Wholesale trade	5.3	2.1	3.2	7.3
Retail trade	17.6	14.8	2.8	6.4
Finance, insurance, and real estate	6.2	3.1	3.1	7.1
Business and repair services	3.3	2.0	1.3	3.0
Personal services	6.9	4.2	2.7	6.2
Entertainment	1.3	.8	.5	1.1
Professional services	10.2	6.9	3.3	7.6
Public administration	8.0	2.7	5.3	12.2
Industry not reported	1.3	.7	.6	1.4

Source: Calculated from U.S. Population Census, 1950.

To substantiate further the validity of the "minimum requirements" method, the procedure was applied to other groups of Standard Metropolitan Areas and cities in descending order of size (300,000–800,000, 100,000–150,000, 25,000–40,000, etc.). As is to be expected, the minimum requirements percentage decreases as the city size decreases, since smaller cities are less self-contained. This procedure was carried out with 1940 data as well as with 1950 data, and the percentages for the various size groups were plotted on a semilogarithmic scale. (See fig. 10.) The points for both sets of percentages exhibit a remarkably straight-line trend and close fit. This forms the basis for predicting the minimums for cities of various sizes. The slope of the regression line extending through the points for 1950 has been calculated, and the resulting formula used for more precise determination of the proper minimums for cities of any size class, including San Francisco. By extending the regression line as shown in figure 10, a basis is provided for estimating that, as of 1958, almost 60 percent of the San Francisco Bay Area's total employment is in the "local market" category and the remainder, about 40 percent, is in the "outside market" employment group. This compares with minimums of approximately 57 and 56 percent. (See table 13.) Extension of the 1950 regression line indicates also that, by the time the San Francisco Bay Area has 10 million inhabitants, a minimum of about 67 percent of employment would be needed for local service, and by the time a 15 million population is reached, the minimum needed for local service would be about 68 percent of employment.

Similarly, linear-regression equations were computed from 1950 data for the 14 industry groups (except mining). The regression lines were plotted on a semilogarithmic scale and, again using the 1958 estimated population of 3,400,000 for the San Francisco Bay Area, the minimum percentages are read off the scale for each industry group. (These percentages are shown as col. D in table 16.) Table 16 is comparable in all respects to tables 14 and 15 except that the minimum percentages required for "local market" employment (col. D) are adjusted for size of city by use of linear-regression equations.

From the foregoing findings arise three significant points useful in guiding the development of long-range projections based on current employment data.

The first point is that, for a very large metropolitan area such as the San Francisco Bay Area, at least 60 percent of total employment needs no explanation other than to point out that this amount

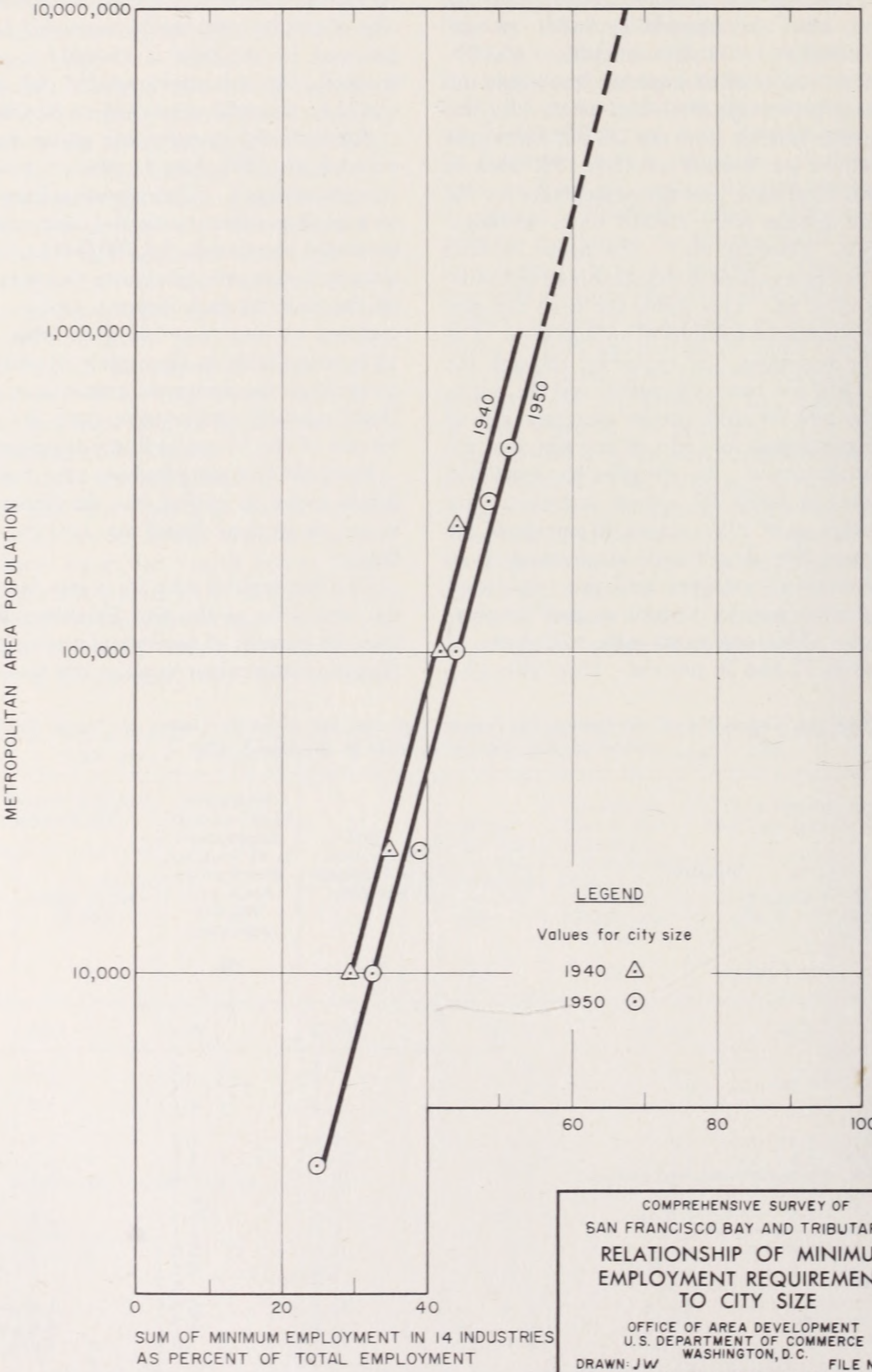
Table 15.—Total and "Outside Market" Employment, San Francisco Bay Area, and Minimums (Unadjusted) "Local Market" Employment from 18 Standard Metropolitan Areas (in Percentages): 1950

Industry	Total employees: San Francisco Bay Area (A)	Minimums "local market" employment in 18 Standard Metropolitan Areas over 800,000 population (B)	"Outside market" employment: San Francisco Bay Area	
			Col. A minus Col. B (C)	Col. C converted to parts of 100 percent (D)
Total	100. 0	56. 4	43. 6	100. 0
Agriculture	3. 8	. 6	3. 2	7. 3
Mining	. 1	. 1	0	0
Construction	7. 4	4. 6	2. 8	6. 4
Manufacturing:				
Durable	9. 4	2. 3	7. 1	16. 3
Nondurable	10. 0	4. 9	5. 1	11. 7
Transportation, communications, and utilities	10. 1	6. 6	3. 5	8. 0
Wholesale trade	5. 1	2. 1	3. 0	6. 9
Retail trade	17. 6	14. 8	2. 8	6. 4
Finance, insurance, and real estate	5. 8	3. 1	2. 7	6. 2
Business and repair services	3. 3	2. 0	1. 3	3. 0
Personal services	6. 8	4. 2	2. 6	6. 0
Entertainment	1. 3	. 8	. 5	1. 1
Professional services	10. 5	6. 9	3. 6	8. 3
Public administration	7. 5	2. 7	4. 8	11. 0
Industry not reported	1. 3	. 7	. 6	1. 4

Source: Calculated from U.S. Population Census, 1950.

CORPS OF ENGINEERS U.S. ARMY

FIGURE 10



COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES

RELATIONSHIP OF MINIMUM EMPLOYMENT REQUIREMENTS TO CITY SIZE

OFFICE OF AREA DEVELOPMENT
U.S. DEPARTMENT OF COMMERCE
WASHINGTON, D.C.

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Table 16.—Minimum Employment Requirements, Adjusted for Size of City, for 14 Major Industries, San Francisco Bay Area: 1950

Industry	Total employment: San Francisco Bay Area		"Local market" employment (minimum requirements)		"Outside market" employment		
	Number [1] (A)	Percent (B)	Number (C)	Percent (D)	Number (E)	Percent of total employment (F)	Percent of excess employment (G)
Total	1, 016, 499	100. 0	608, 739	59. 8	407, 760	40. 1	100. 0
Agriculture	38, 742	3. 8	11, 283	1. 1	27, 459	2. 7	6. 7
Mining	1, 429	. 1	0	0	1, 429	. 1	. 4
Construction	75, 186	7. 4	53, 874	5. 3	21, 312	2. 1	5. 2
Manufacturing:							
Durable	97, 097	9. 6	36, 289	3. 6	60, 808	6. 0	14. 9
Nondurable	101, 305	10. 0	56, 212	5. 5	45, 093	4. 4	11. 1
Transportation, communications, and utilities	102, 975	10. 1	52, 451	5. 2	50, 524	5. 0	12. 4
Wholesale trade	51, 730	5. 1	26, 937	2. 6	24, 793	2. 4	6. 1
Retail trade	178, 666	17. 6	147, 494	14. 5	31, 172	3. 1	7. 6
Finance, insurance, and real estate	59, 083	5. 8	24, 599	2. 4	34, 484	3. 4	8. 5
Business and repair services	33, 018	3. 2	22, 770	2. 2	10, 248	1. 0	2. 5
Personal services	69, 442	6. 8	43, 303	4. 3	26, 139	2. 6	6. 4
Entertainment	12, 830	1. 3	9, 047	. 9	3, 783	. 4	. 9
Professional services	107, 210	10. 5	85, 488	8. 4	21, 722	2. 1	5. 3
Public administration	75, 834	7. 5	31, 918	3. 1	43, 916	4. 3	10. 8
Industry not reported	11, 952	1. 2	7, 074	. 7	4, 878	. 5	1. 2

[1] Source: U.S. Population Census, 1950.

is necessary to service local needs. The balance, or about 40 percent, needs explanation or justification in terms of the character of the area's economic potential.

Second, as the San Francisco Bay Area expands in population to the order of 12–15 million, the balance between "local market" and "outside market" employment will shift from the estimated present ratio of 60:40 closer to 68:32.

Third, the emphasis accorded the various categories of economic activities should be adjusted to match the contribution that each category makes to total "outside market" employment.

From table 16 it is noted that manufacturing (durable and nondurable) engages just under 20 percent of all workers in the San Francisco Bay Area, but it contributes 26 percent of the "outside market" employment and is, therefore, the most important component in the economic base of the San Francisco Bay Area. Within manufacturing, production of durable goods is heavily oriented to the "outside market," whereas well over half of the employment in nondurable goods is needed to meet "local market" requirements.

Trade (wholesale plus retail employment) is the leading major industry of the Bay Area as measured by number of employees, but it contributes barely 14 percent of the "outside market" employment. Thus, trade is only half as important as manufacturing as a source of economic support from outside the San Francisco Bay Area.

Similarly, the service industries (business and repair, personal, entertainment, and professional) contribute only 15 percent of "outside market" employment although they employ almost 22 percent of all workers.

Of the remaining major employment categories in the San Francisco Bay Area, three—transportation, communications, and public utilities; public administration; and finance, insurance, and real estate—contribute a half to twice as much to the "outside market" portion of the San Francisco Bay Area economy as they contribute to local service.

According to tables 14, 15, and 16, agriculture also contributes more to the "outside market" than it does to the "local market" requirements. Here, however, caution is needed, since the situation points up one of the shortcomings in comparing data for the nine-county San Francisco Bay Area with data for the large Standard Metropolitan Areas. As noted earlier, Santa Clara, Napa, and Sonoma Counties have large fractions of their employment in agriculture. Including them with the six counties in the San Francisco-Oakland Standard

Metropolitan Area distorts the picture with respect to agriculture's contribution to "outside market" employment. Thus, instead of values of 6.7 percent in column G, table 16, or 7.3 percent shown in column D, table 15, a figure nearer to 3 or 4 percent, as shown in column D, table 14, is probably a better measure of agriculture's contribution to the total "outside market" employment for the San Francisco Bay Area. Even with this deflation, agriculture still contributes proportionally much more to support of the San Francisco Bay Area economy through the "outside market" than it contributes to meet local-service demands.

As is to be expected, construction, the only remaining major employment category, is similar to the trade and services industries in that it also contributes proportionally much less to "outside market" employment than it contributes to the demands of the local market.

This analysis of the contribution of the 14 major industry types to the support of the San Francisco Bay Area economy forms the basis for establishing the order of presentation and the emphasis accorded the eight divisions of economic activity for which employment projections are discussed later in this chapter.

32. *Recent Growth of Employment in San Francisco Bay Area*

As is apparent from table 17, employment in the San Francisco Bay Area expanded at differential rates from one segment of the economy to another from 1950 to 1957. While most segments added large numbers of employees, only the service industries (business, personal, and professional) and manufacturing showed gains much higher than the 21-percent increase for the Bay Area economy as a whole. Service industries added about 64,200 employees for a gain of about 30 percent, while manufacturing employment increased by 57,700, or more than 25 percent. Government added 19,400 for a gain of about 22 percent, which was only slightly greater than the gain for all categories of employment. The other segments of the economy expanded substantially in absolute terms, but their percentage gains were below that of the Bay Area economy in general. Finance, insurance, and real estate increased 19 percent; employment both in transportation, communications, and public utilities, and in trade (wholesale and retail) increased 17 percent, while employment in construction and in agriculture rose about 13 percent.

Bearing in mind the comparison of minimum requirements of each of the major employment categories that are needed to supply local requirements shown in table 16, it is clear—not only in terms of absolute growth and percentage growth as cited above, but also in terms of the probable contribution of outside support for the local economy—that manufacturing is, by a considerable margin, the key factor in current growth of the San Francisco Bay Area economy. This point is demonstrated in table 18, which indicates that up to 53 percent, or 30,000 of the 57,700 employees added in manufacturing operations between 1950 and 1957, are producing to satisfy demands over and above local requirements. (The 53 percent is obtained from table 16 by computing the sum of manufacturing employment (durable and nondurable) in col. E as a percentage of the sum of manufacturing employment in col. A.) Thus, according to these calculations, manufacturing is 66 percent more important than are service industries in its contribution to the economic base of the San Francisco Bay Area, and it is almost as important as the combined contributions of trade, transportation, and government, although the latter three categories added 26,000 more employees than were added by all manufacturing activities between 1950 and 1957. Table 18 also indicates that, because employment in the construction industry is devoted largely to supplying local needs, its contribution to growth of the Bay Area from outside sources is not as great as that of agriculture, which had a smaller absolute growth from 1950 to 1957. (The 5,000 employees ascribed to agriculture in table 18, col. D, is an estimate. Greater accuracy would involve applying a correction factor to offset the aforementioned fact that the San Francisco Bay Area, as defined in this report, includes two rural counties and that, by definition, rural counties are excluded from Standard Metropolitan Areas. Such a level of accuracy is not needed to satisfy the purposes of this study.)

(*a*) *Manufacturing.*—Between 1950 and 1957, the number of persons engaged in manufacturing in the Bay Area ranged between 20 and 22 percent of the actual annual employment. (See table 17.) The high was reached in 1953, when local production facilities were spurred to meet the material needs of the Korean conflict.

Employment in manufacturing in the Bay Area is well distributed among 10 of the major manufacturing industry groups. (See table 19.) The leader among these 10 groups, food and kindred

Table 17.—Total Employment in the San Francisco Bay Area by Major Industry Divisions: 1950–57 [1]

Major industry divisions	1950		1951		1952		1953		1954		1955		1956		1957		Percent increase, 1950–57
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent total employment	Number of employees	Percent total employment	Number of employees	Percent total employment	Number of employees	Percent total employment	
	Thousands		*Thousands*		*Thousands*		*Thousands*		*Thousands*		*Thousands*		*Thousands*		*Thousands*		
All industry divisions	1,117.7	100.0	1,180.5	100.0	1,209.1	100.0	1,238.2	100.0	1,212.7	100.0	1,255.2	100.0	1,303.7	100.0	1,355.3	100.0	21.3
Construction	82.6	7.4	87.3	7.4	88.0	7.3	79.2	6.4	86.6	7.1	93.3	7.4	95.2	7.3	92.8	6.8	12.3
Manufacturing	224.0	20.0	250.0	21.2	251.0	20.7	268.0	21.6	256.5	21.2	254.8	20.3	268.9	20.6	281.7	20.8	25.8
Transportation, communications, and utilities	120.5	10.8	130.5	11.1	130.2	10.8	136.4	11.0	127.8	10.5	131.7	10.5	136.4	10.5	141.4	10.4	17.3
Wholesale and retail trade	257.3	23.0	264.0	22.4	271.9	22.5	276.7	22.4	263.8	21.8	285.7	22.8	292.9	22.5	301.3	22.2	17.1
Finance, insurance, and real estate	66.4	5.9	69.1	5.8	70.9	5.9	71.0	5.7	71.7	5.9	76.4	6.1	77.5	5.9	79.3	5.9	19.4
Services	216.3	19.4	228.3	19.3	232.2	19.2	239.1	19.3	245.0	20.2	254.3	20.2	266.7	20.5	280.5	20.7	29.7
Government	88.4	7.9	107.4	9.1	107.6	8.9	105.0	8.5	100.9	8.3	102.5	8.2	105.6	8.1	107.8	8.0	21.9
Agriculture	57.8	5.2	40.8	3.4	53.2	4.4	58.3	4.7	56.1	4.6	52.5	4.2	56.2	4.3	65.5	4.8	13.3
All other	4.4	.4	3.1	.3	4.1	.3	4.5	.4	4.3	.4	4.0	.3	4.3	.3	5.0	.4	13.6

[1] Employment totals covering wage and salary workers, self-employed and unpaid family workers, and domestics are adjusted to include Napa and Sonoma Counties.

Source: State of California, Department of Employment, Research and Statistics, Coastal Area.

Table 18.—Increase in Employment and Estimated Contribution to Economic Base, by Major Industry Divisions: 1950–57

Major industry division	Increase in employment, 1950–57		Percent in "outside market" employment	Contribution to economy (cols. A×C)
	Number	Percent		
	(A)	(B)	(C)	(D)
Services	64,200	29.7	28	17,976
Manufacturing	57,700	25.8	53	30,581
Trade	44,000	17.1	24	10,560
Transportation, communications, and utilities	20,900	17.3	49	10,241
Government	19,400	21.9	58	11,252
Finance, insurance, and real estate	12,900	19.4	58	7,482
Construction	10,200	12.3	28	2,856
Agriculture	7,700	13.3	(1)	[2] 5,000

[1] Not readily calculated.

[2] Estimate.

Table 19.—Total Manufacturing Employment in The San Francisco Bay Area by Major Industry Groups: 1950–58[1]

Major industry groups	1950		1951		1952		1953	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
	Thousands		*Thousands*		*Thousands*		*Thousands*	
All industry groups	224.0	100.0	250.0	100.0	251.0	100.0	268.0	100.0
Food	49.7	22.2	50.6	20.2	49.9	19.9	52.0	19.4
Paper	5.1	2.3	5.4	2.2	5.7	2.3	7.1	2.6
Printing and publishing	18.5	8.3	18.4	7.3	18.5	7.4	20.1	7.5
Chemicals	12.8	5.7	13.6	5.4	13.1	5.2	13.8	5.2
Petroleum	14.8	6.6	14.9	6.0	14.7	5.8	15.1	5.6
Stone, clay, and glass	7.7	3.4	8.0	3.2	8.1	3.2	8.7	3.2
Primary metals	13.5	6.0	15.4	6.1	13.3	5.3	14.5	5.4
Fabricated metals	19.5	8.7	21.7	8.7	22.0	8.8	22.7	8.5
Nonelectrical machinery	14.4	6.4	19.4	7.8	19.0	7.6	19.7	7.4
Electrical machinery	7.5	3.4	11.2	4.5	12.9	5.1	15.0	5.6
Transportation equipment	29.3	13.1	41.2	16.5	44.1	17.6	46.1	17.2
All other	31.2	13.9	30.2	12.1	29.7	11.8	33.2	12.4

Major industry groups	1954		1955		1956	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
	Thousands		*Thousands*		*Thousands*	
All industry groups	256.5	100.0	254.8	100.0	268.9	100.0
Food	51.3	20.0	51.5	20.2	52.3	19.5
Paper	7.5	2.9	7.8	3.1	8.6	3.2
Printing and publishing	20.2	7.9	20.0	7.9	21.5	8.0
Chemicals	13.8	5.4	13.1	5.1	13.7	5.1
Petroleum	15.0	5.8	14.8	5.8	15.3	5.7
Stone, clay, and glass	9.0	3.5	9.0	3.5	9.5	3.5
Primary metals	12.7	5.0	12.9	5.1	13.3	5.0
Fabricated metals	22.1	8.6	22.1	8.7	23.4	8.7
Nonelectrical machinery	19.9	7.8	19.6	7.7	22.1	8.2
Electrical machinery	13.9	5.4	14.1	5.5	18.6	6.9
Transportation equipment	39.7	15.5	35.9	14.1	36.7	13.6
All other	31.4	12.2	34.0	13.3	33.9	12.6

Major industry groups	1957		1958		Percent increase, 1950–56[3]
	Number of employees	Percent total employment	Number of employees	Percent total employment	
	Thousands		*Thousands*		
All industry groups	[2] 274.8	100.0	269.1	100.0	20.0
Food	58.0	21.1	54.9	20.4	5.2
Paper	8.9	3.2	9.3	3.5	68.6
Printing and publishing	20.6	7.5	20.7	7.7	16.2
Chemicals	13.6	5.0	12.9	4.8	7.0
Petroleum	12.8	4.7	12.1	4.5	3.4
Stone, clay, and glass	10.0	3.6	10.0	3.7	23.4
Primary metals	13.5	4.9	13.6	5.1	−1.5
Fabricated metals	23.4	8.5	22.4	8.3	20.0
Nonelectrical machinery	22.2	8.1	17.7	6.6	53.5
Electrical machinery	22.9	8.3	23.0	8.5	148.0
Transportation equipment	34.7	12.6	33.2	12.3	25.3
All other	34.2	12.5	39.3	14.6	8.7

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[1] Employment totals covering wage and salary workers, self-employed and unpaid family workers, and domestics are adjusted to include Napa and Sonoma Counties.

[2] Note that this figure is about 3 percent lower than the corresponding figure in table 17. The latter is an estimate calculated early in 1957.

[3] Base period (see p. 49).

Source: State of California, Department of Employment, Research and Statistics, Coastal Area.

products, currently employs less than 20 percent of all manufacturing employees. The distribution of manufacturing employment, moreover, is about evenly divided between durable goods (metals, machinery, transportation, etc.) and nondurable goods (food, paper, printing and publishing, chemicals, etc.). The broad distribution of manufacturing employment, coupled with a 54:46 percent division between durable and nondurable goods, gives the Bay Area a well-balanced and diversified manufacturing economy.

During the present decade, the most notable development has been the rapid growth of the durable-industry groups. This development has had the effect of reducing the relative importance of the industry groups that hitherto had dominated manufacturing in the Bay Area. Thus, food products dropped from 22 percent of metropolitan area employment in 1950 to less than 20 percent in 1956 and 1957.

Other industry groups that lost relative position during the 7-year span include chemicals, petroleum products, textiles and apparel, lumber and furniture, and primary metals (largely due to a decline in foundry and scrap reclamation operations). During this time, absolute losses in numbers of employees were confined to only two categories—lumber and furniture, and textiles and apparel. In the overall picture, both the absolute and relative losses in these industries were more than offset by the increasing employment in four major industry groups: fabricated metals, electrical machinery, nonelectrical machinery, and paper. Three other industry groups—printing and publishing; stone, clay, and glass; and transportation equipment—gained employment in the absolute sense but registered essentially no change in their relative standings with respect to the other groups.

Even with the substantial industrial expansion during and since World War II, manufacturing is still less well developed in the Bay Area's economy than it is in California as a whole or most metropolitan centers in the northeastern part of the country. This is reflected by 1950 census data which indicate that the portions of total employment in manufacturing in the Bay Area and California were just under 20 percent, whereas for the country as a whole the proportion was almost 26 percent of total national employment.

In 1957, in terms of nonagricultural employment, the Bay Area had about 24 percent in manufacturing, the State had about 26 percent, and the United States about 30 percent (121, p. 516).

(*b*) *Service industries.*—Between 1950 and 1957, service industries ranked third among the major economic components of the San Francisco Bay Area in percentage of total employment. During the 7-year period, the industry's portion of total employment rose from 19 percent in 1951 to almost 21 percent in 1957. This industry group is a heterogeneous one, which includes domestic and personal service workers as its chief component. It encompasses hotels, restaurants, laundries, and cleaning establishments, all of which are unusually well represented in the Bay Area. Next are the professional and semiprofessional services. Professional services—legal, medical, educational, etc.—have expanded rapidly in the Bay Area, and this is one of the chief reasons for the rising employment in this heterogeneous group of activities. Recreation and amusements form an important element of semiprofessional services.

According to the 1954 Census of Business, service industries in the San Francisco Bay Area that year consisted of over 20,000 establishments with total receipts of $643 million. This compares with 12,500 establishments and $231 million in receipts in 1948, the last previous year of a U.S. business census. Thus, both the dollar volume of business and the employment ratio of the service industries reflect the fact that the Bay Area is of growing importance as a commercial and tourist center.

The service activities are relatively more important in the San Francisco Bay Area than they are in California as a whole. Since 1950, only 15 to 16 percent of total State employment has been in services. Furthermore, while the share of the service industries in total employment has been rising in the Bay Area during the past decade, it has actually fallen somewhat on a statewide basis, due largely to declines in motion-picture production.

(*c*) *Wholesale and retail trade.*—Employment in wholesale and retail trade for the nine-county Bay Area fluctuated between 21 and 23 percent of the total labor force from 1950 to 1957. During this period, by a relatively small margin, trade was consistently the chief source of livelihood in the Bay Area.

The proportion of the labor force employed in trade is higher than the proportion on a national basis. This reflects the long-established position of the Bay Area as a wholesaling center for a wide area.

Wholesalers and retailers in the Bay Area handle domestic and export shipments of agricultural products from the Central Valley and coastal valleys, and they distribute producers' and consumers' goods throughout northern California, western Nevada, and southwestern Oregon.

No evidence is found in the Bay Area data for the base period to indicate that trade activities are changing in relative importance with respect to other facets of the economy. At the State level, where trade is of about the same relative importance as it is in the San Francisco Bay Area, the relative position of trade has dropped slightly, from 23 percent to a little less than 22 percent of total employment.

In 1954, the Bay Area's merchant wholesale business amounted to $2.5 billion. This was about one-fourth higher than the $2 billion total reached in 1948. Yet the relative position of the Bay Area as a wholesale center for the State declined from 36 percent of total California wholesale sales in 1948 to 30 percent in 1954. This is attributable to two influences: First, the Los Angeles-Long Beach area grew as a wholesaling center, increasing its share of sales in the State from 46 to 50 percent; and, second, cities in the Central Valley and elsewhere grew as wholesale centers because of local population growth and industrial expansion. Similarly, although retail sales increased in the Bay Area from $2.8 to $3.7 billion between 1948 and 1954, the Bay Area's share of the State's total retail sales declined from 26 to 24 percent.

(*d*) *Transportation, communications, and public utilities.*—Transportation, communications, and public utilities supplied a livelihood for between 10 and 11 percent of labor force employed in the San Francisco Bay Area between 1950 and 1957. In 1950, 7.5 percent of civilian employment in the State was in this field; by 1957 the percentage for the State had declined to 6.5 (121). The high percentage of total employment in this economic division for the San Francisco Bay Area reflects the longstanding significance of San Francisco as a transportation center and distribution point for goods in foreign and domestic commerce for a large part of the Western United States—a region of great distances and therefore one in which transportation and communication costs loom large in business accounts.

The decline in relative importance of employment in this industry, which is suggested by the percentages cited above for the State, is reflected also to a lesser degree in the employment data for the San Francisco Bay Area. (See table 18.) In recent years, employment totals in rail and local transportation have declined. These declines have been balanced by large gains in air and truck transport and steady gains in employment in communications and public utilities, but the net effect of this shift has been insufficient to move the relative position of total employment in these categories with respect to employment in all lines of endeavor (121).

(*e*) *Government.*—From 1950 to 1957, government employment in the San Francisco Bay Area ranged from about 8 to 9 percent of total employment. During this period, government employment on the State level was relatively more important, rising from almost 13 percent of the total in 1950 to 14 percent in 1957. In the Bay Area, as indicated in table 18, the 19,000 employees added to government employment were merely enough to maintain the category at about 8 percent of total employment. In both the State and the Bay Area, the preponderance of new employment has been added to State and local government payrolls in order to meet the demands of the expanding population.

(*f*) *Finance, insurance, and real estate.*—Since long before the headquarters of the Federal Reserve Bank was located in San Francisco, that city has been the leading financial center in the Western United States. The continuing prominence of this function largely explains why employment in this category in the San Francisco Bay Area averaged about 6 percent of total employment as compared to 4 percent for the State. Employment in this field of activity has risen at almost the same rate as the rise in total employment. (See table 18.)

(*g*) *Construction.*—The most notable rise in relative importance of employment in construction in both the State and Bay Area occurred in the late 1940's, during the transition from a wartime to a peacetime economy. Despite continued growth in population and industrial intensity in the Bay Area, since 1950 the employment increase in this field has not kept pace with the growth of total employment. Mainly because of a reduction in employment between 1956 and 1957, this industry has had a net increase of about 12 percent compared to 21 percent for employment in all industries between

1950 and 1957. As shown in table 18, construction employment has averaged a little over 7 percent of total employment, except for 1957. This indicates that the industry is a slightly more important source of employment in the Bay Area than it is in the State as a whole, where in recent years it has averaged about 6.5 percent of total employment.

(*h*) *Agriculture.*—As noted earlier, agriculture is the only major economic activity in the Bay Area that is undergoing decline in relative importance as measured by employment. This decline has been rather unsteady and, between 1950 and 1957, the industry actually had an incremental gain of over 7,000 employees. (See table 18.) Most of this gain occurred in Santa Clara County, which, on the average, employs about 40 percent of all agricultural workers in the San Francisco Bay Area.

(*i*) *Other industries.*—Chief among the economic activities in this final category are mining, forestry, and fishing, which total about 4,000 employees, or less than one-half of 1 percent of total employment. These extractive activities have been undergoing a slow decline in both absolute and relative terms.

EMPLOYMENT PROJECTIONS FOR SAN FRANCISCO BAY AREA: 1960–2020

Projections of economic growth for the San Francisco Bay Area from 1960 to 2020 are based upon an analysis of trends in employment for eight major components of economic activity, using the 7-year span 1950–57 as the base period.

Employment levels that have been projected for major economic divisions for decades 1960 through 2020 are listed in table 20 and illustrated by figure 11.

33. Method and Procedure

Selection of employment, in preference to income or value of goods and services, to project economic growth was dictated in part by problems of assembling comparable data and in part by the close and widely recognized association between employment potential and growth of population. Since detailed local employment data were available on an annual basis from California State agencies, and since estimation of population growth is the key point directly or indirectly motivating all segments of this report, employment was chosen as the medium through which to analyze and project economic growth in the Bay Area.

Choice of 1950–57 as the base period from which to project future employment levels was made following study of data available from the Federal censuses of population, business, and manufactures. From this examination, it was concluded that the pattern of economic growth since 1950 was far more indicative of both rate of expansion and the probable character of future economic growth of the Bay Area counties than was the pattern for the two decades prior to 1950. As noted earlier, the Bay Area counties have grown at a slower pace since 1950 than during the 1940's and slower also than the other major urban areas in California since 1950. The choice of the 1950–57 growth rates as a basis for projection is, therefore, a conservative one.

Table 20.—Projected Total Employment by Major Industry Divisions, San Francisco Bay Area: 1960–2020

Major industry divisions	1960		1970		1980		1990	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
	Thousands		*Thousands*		*Thousands*		*Thousands*	
All industry divisions	1,471	100.0	1,818	100.0	2,349	100.0	2,969	100.0
Construction	97	6.6	111	6.1	139	5.9	157	5.3
Manufacturing	316	21.5	442	24.3	597	25.4	775	26.1
Transportation, communications, and utilities	150	10.2	173	9.5	214	9.1	249	8.4
Wholesale and retail trade	321	21.8	398	21.9	519	22.1	674	22.7
Finance, insurance, and real estate	85	5.8	103	5.7	136	5.8	163	5.5
Services	321	21.8	398	21.9	517	22.0	680	22.9
Government	116	7.9	140	7.7	183	7.8	232	7.8
Agriculture	60	4.1	49	2.7	42	1.8	36	1.2
All other	5	.3	4	.2	2	.1	3	.1

Table 20.—Projected Total Employment, by Major Industry Divisions, San Francisco Bay Area: 1960–2020—Continued

Major industry divisions	2000		2010		2020		Increase, 1957–2020	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent change
	Thousands		*Thousands*		*Thousands*		*Thousands*	
All industry divisions	3,386	100.0	4,390	100.0	5,331	100.0	3,976	293.4
Construction	176	5.2	228	5.2	272	5.1	179	192.5
Manufacturing	850	25.1	1,067	24.3	1,279	24.0	997	353.5
Transportation, communications, and utilities	281	8.3	364	8.3	443	8.3	302	214.2
Wholesale and retail trade	786	23.2	1,032	23.5	1,263	23.7	962	319.6
Finance, insurance, and real estate	190	5.6	250	5.7	309	5.8	230	291.1
Services	792	23.4	1,045	23.8	1,274	23.9	993	353.4
Government	267	7.9	356	8.1	443	8.3	335	310.2
Agriculture	41	1.2	44	1.0	43	.8	−23	−65.2
All other	3	.1	4	.1	5	.1	....	....

At an early stage in the investigation, projection of employment by individual counties was considered. The approach was discarded as impracticable in terms of available data and unrealistic in view of the large measure of intercounty commuting and economic interdependence which characterize most of the nine Bay Area counties.

The procedure used in developing the projections involved extension of current growth rates, followed by adjustments in the rate of future growth based on judgmental factors derived from many sources, including interview and consultation with specialists in industry and students of economic growth at local, State, and National levels.

Specifically, annual growth rates of employment from 1950 through 1957 were determined for the major economic divisions, and the assumption was made that these rates would continue to 1960. Subsequently, as local employment data for 1958 and for the early part of 1959 became available, this assumption was reexamined. These more recent data reflected the effects of the 1957–58 recession upon some sectors of the Bay Area economy. It was decided, however, not to introduce the slight downward readjustment of the 1950–57 annual rates that would have resulted from incorporating the employment values for 1958.

To obtain the projected employment values for subsequent decades, 1950–60 growth rates were projected to the terminal decade. The resulting values were then substantially adjusted to accommodate several major judgmental determinations regarding the probable composition and size of the economy during and at the close of the study period. The more important of these determinations are the following:

1. As the San Francisco Bay Area becomes larger and more mature, its rate of accretion of population and employment will decline.

2. Although the profile of percentage distribution of employment by major economic categories in 2020 will resemble the profile in 1960, it will differ in that three major categories—manufacturing, trade, and services—will be more dominant than they are at present.

3. The relative importance of manufacturing employment will increase rapidly in the early decades and slow down in the latter decades.

4. The ratio of employment in agriculture to total employment will decline throughout the study period.

5. Employment in government will increase only slightly in relation to total employment.

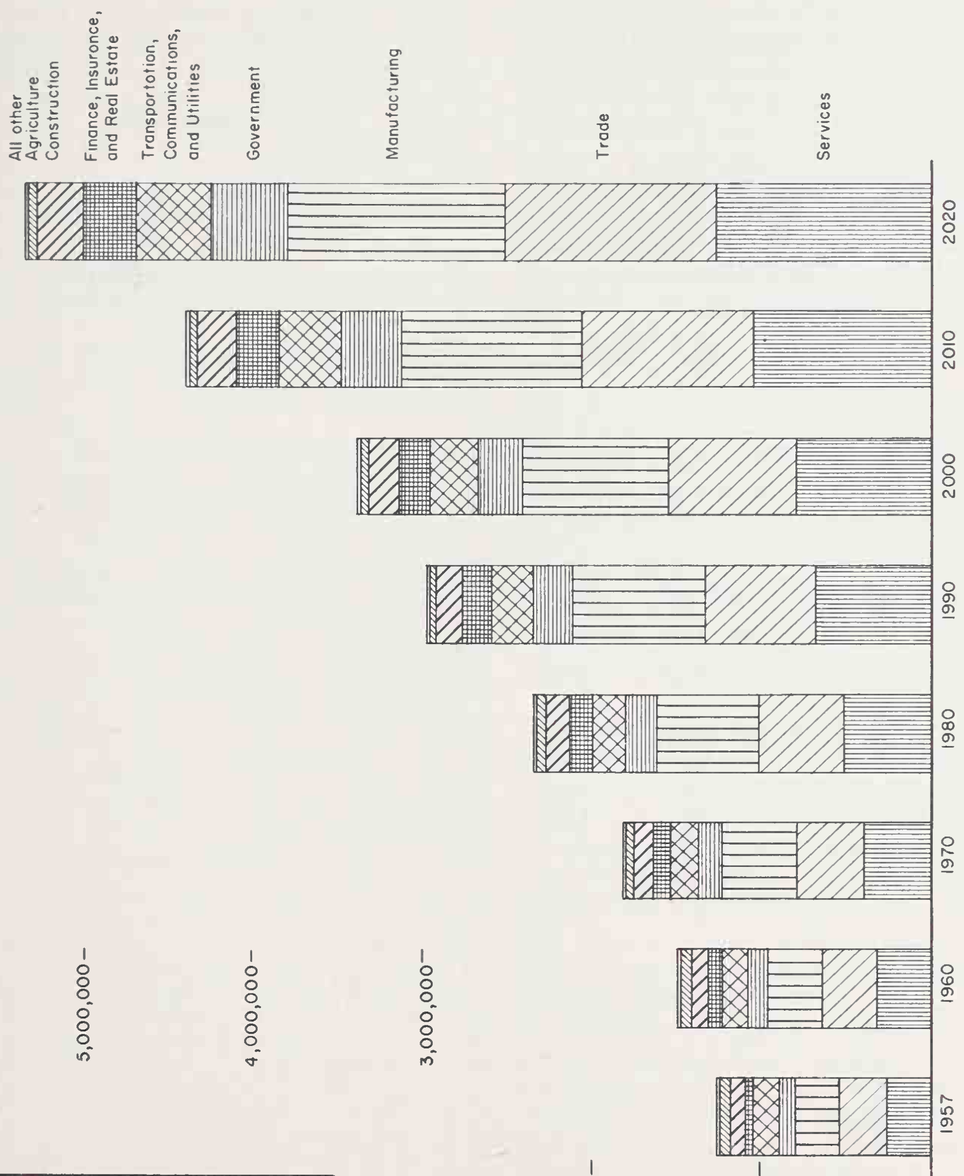
6. During the study period, the growth trend will be affected by an assumed 30-year cycle of interrupted growth. (See ch. II, p. 17.)

The effect of each of these judgmental determinations is evident in projected employment (see table 20) with possible exception of the first—the assumed slowdown in rate of growth in the latter decades. This tendency for a decline in the decade-to-decade growth rates is largely obscured by the cyclical movements assumed for the economy. Nevertheless it should be noted that the rate of growth for the terminal decade is lower than the rates from 1950 to 1960 or from 1960 to 1970, in the first period of assumed slower growth.

The employment levels projected through 2020 for each of the major economic divisions are discussed in the following section, beginning with employment in manufacturing which, because of its expected impact upon future growth of the San

CORPS OF ENGINEERS U. S. ARMY

FIGURE 11



COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES

TOTAL EMPLOYMENT BY MAJOR INDUSTRY DIVISIONS, S.F. BAY AREA: PROJECTED TO 2020

OFFICE OF AREA DEVELOPMENT
U. S. DEPARTMENT OF COMMERCE
WASHINGTON, D. C.

DRAWN: JW FILE NO.
TRACED: JW TO ACCOMPANY REPORT
CHECKED: JKF DATED: Dec. 1959

Francisco Bay Area, is treated more fully than are the other major economic divisions. The discussion for each division incorporates, insofar as it can be developed, the reasoning or justification for the projected employment values. In view of the extreme difficulty of developing a factual and rational basis for substantiating even short-term projections, projections beyond 1970 in table 20 must be viewed, at best, as rough approximations.

34. Employment in Manufacturing

Almost 1 million employees will be added to the work force in manufacturing in the Bay Area by 2020—an increase of 350 percent over the number of employees in manufacturing in 1957. (See tables 17 and 21). Total manufacturing employment in 2020 will be 24 percent of total employment in all economic divisions. These projected values of manufacturing employment are distributed, decade by decade, among 11 major industry groups and an "All other" category, in table 21. The "All other" residual includes the following major industry groups:

NONDURABLE

- Tobacco
- Textile mill products
- Apparel and related products
- Rubber products
- Leather and leather products
- Miscellaneous manufactures

Table 21.—Projected Manufacturing Employment, by Major Industry Groups, San Francisco Bay Area: 1960–2020

Major industry groups	1960		1970		1980		1990		2000		2010		2020		Percent change, 1956–2020
	Number of employees	Percent of all manufacturing	Number of employees	Percent of all manufacturing	Number of employees	Percent of all manufacturing	Number of employees	Percent of all manufacturing	Number of employees	Percent of all manufacturing	Number of employees	Percent of all manufacturing	Number of employees	Percent of all manufacturing	
	Thousands		*Thousands*		*Thousands*		*Thousands*		*Thousands*		*Thousands*		*Thousands*		
All industry groups	315.9	100.0	442.0	100.0	596.9	100.0	775.1	100.0	850.1	100.0	1,067.1	100.0	1,279.0	100.0	375.6
Food	55.3	17.5	65.9	14.9	81.2	13.6	101.5	13.1	109.7	12.9	134.4	12.6	150.9	11.8	188.5
Paper	12.0	3.8	19.0	4.3	25.7	4.3	31.8	4.1	34.0	4.0	41.6	3.9	46.0	3.6	434.9
Printing and publishing	23.7	7.5	30.9	7.0	40.6	6.8	50.4	6.5	54.4	6.4	66.2	6.2	76.7	6.0	256.7
Chemicals	18.0	5.7	28.7	6.5	38.8	6.5	48.8	6.3	54.4	6.4	69.4	6.5	89.5	7.0	553.3
Petroleum	16.4	5.2	17.7	4.0	19.1	3.2	21.7	2.8	21.3	2.5	25.6	2.4	30.7	2.4	100.7
Stone, clay, and glass	11.4	3.6	15.9	3.6	22.7	3.8	33.3	4.3	37.4	4.4	46.9	4.4	53.7	4.2	465.3
Primary metals	13.9	4.4	23.0	5.2	30.4	5.1	38.8	5.0	40.8	4.8	49.1	4.6	57.6	4.5	333.1
Fabricated metals	29.1	9.2	46.0	10.4	72.8	12.2	96.9	12.5	108.8	12.8	145.1	13.6	182.9	14.3	681.6
Nonelectrical machinery	28.4	9.0	49.5	11.2	77.6	13.0	106.2	13.7	119.0	14.0	149.4	14.0	184.2	14.4	733.5
Electrical machinery	26.2	8.3	44.6	10.1	69.8	11.7	106.2	13.7	125.8	14.8	169.7	15.9	213.6	16.7	1,048.4
Transportation equipment	40.1	12.7	46.9	10.6	52.5	8.8	61.2	7.9	62.9	7.4	71.5	6.7	81.9	6.4	123.2
All other	41.4	13.1	53.9	12.2	65.7	11.0	78.3	10.1	81.6	9.6	98.2	9.2	111.3	8.7	228.3

DURABLE

- Furniture and fixtures
- Lumber and wood products
- Instruments and related products

Procedures used to develop the data in table 21 were generally the same as those used to project employment for major economic divisions (see pp. 45–48), with two exceptions. First, since final, detailed manufacturing employment data for 1957 were not available at the time the projections were developed, 1950–1956 was made the base period for projection. (See table 19.) Second, rates applied to the 1950–56 average annual growth to arrive at estimates for 1960 were substantially adjusted to reflect facts developed by field inquiry concerning industry's plans for expansion in the Bay Area, and to yield a product consistent with the projection for total manufacturing employment shown in table 21.

As an example of growth-rate adjustment based on facts developed by field interview, it is assumed that within the next decade the Bay Area will acquire an integrated primary-metals producing facility. Products of such an establishment would provide impetus for expanded operations by a variety of durable-goods producers, who are dependent upon an adequate local source of raw material. The effect of this critical assumption is reflected in table 21, which indicates that, during the next six decades, three industry groups in the durable-goods field—fabricated metals, electrical machinery, and nonelectrical machinery—will each well surpass food products (now the principal manufacturing industry), and that by 2020 these three major groups together will supply employment for almost 50 percent of all manufacturing workers. Four industries that are now relatively prominent—food, printing and publishing, petroleum, and transportation equipment—will grow at much lower rates and contribute substantially less to the growth of manufacturing during the period under study.

As shown in table 20, after 1990 the importance of manufacturing as measured by employment is projected as undergoing a gradual decline in relation to other major economic divisions. This decline reflects the assumption that, in the later decades, automation probably will have a proportionally greater impact in reducing labor requirements in fabrication processes than it will have on most other activities. However, even though the relative importance of production employment in manufacturing gradually declines, operation and maintenance requirements of industrial plants will continue to have a direct and beneficial effect upon employment levels in such other brackets of the local economy as trade, transportation, communications, utilities, and service industries.

(a) *Factors relating to manufacturing growth potential.*—Growth possibilities for manufacturing are favorable for several reasons: First, ample land, including waterfrontage, suited to industrial requirements, is available in the San Francisco Bay Area (see ch. IV, Land for Urban Needs); second, there are expected large expansions of markets for manufactured products in California, other Western States, and probably the Orient; third, the relative underdevelopment of manufacturing in the Bay Area for lack of adequate markets in the past presents a condition which suggests there is now room for considerable growth; fourth, there are possible further increases in freight rates in the long haul of eastern manufactured goods to the Far West; and, fifth, there are locally available research and scientific facilities, resources, and personnel. These factors are already contributing to the Bay Area's growing industrial diversification, including the rapid expansion of many of the Nation's "growth" industries, such as electrical and other machinery, transportation equipment, and chemicals.

With respect to market expansion, the point has been made earlier that, as urban areas increase in size, they become more self-contained. (See fig. 10.) This tendency by itself will create a large demand for production of local goods to meet Bay Area needs. As manufacturing expands to satisfy the local market, lower unit costs resulting from economies of scale will simultaneously improve the Bay Area's competitive position with respect to markets in northern California, the Western United States, and the Orient.

Availability of a pool of scientific and technical personnel is of particular importance in estimating the Bay Area's future industrial growth. This pool will serve not only to hold industries already in the Bay Area, but will operate also to create additional new products which will result in more producing plants. The availability of such personnel also will be a powerful attraction to many of the new-product industries of the future not yet located in the Bay Area. This is because the trend is for technical- and engineer-based industries to use greater proportions of engineers than do many of the older established industries.

Although, as pointed out earlier, manufacturing is broadly based and is well diversified, underdevelopment is apparent in that only 85 persons per thousand are engaged in manufacturing activities. This rate is about half the rate of most of the large industrialized metropolitan centers. (See table C–1, app. C.) Were this rate to undergo a modest increase to as much as 90 per thousand, by the time the Bay Area would have attained a population of 15 million it would have a manufacturing force on the order of 1,350,000.

Among the foregoing factors, a key item which places the San Francisco Bay Area in a strong position to move forward into new economic growth and a buildup of employment is the Bay Area's widely diversified manufacturing base. A well-diversified area is in a good position to weather cyclical fluctuations in the economy and to share in the future national growth of a broad segment of the industrial economy. The manufacturing industry diversification index, based on 142 Standard Industrial Classification categories, developed by the Office of Area Development (see app. C), indicates that the San Francisco-Oakland Standard Metropolitan Area, with an index of 66.8, ranked third highest among all Standard Metropolitan Areas in the country in 1954 (158).

(*b*) *Survey of industry and business plans for expansion in the Bay Area.*—Subsequent to development of projections for manufacturing employment, a national cross-section survey of industry and business plans for future expansion and construction of production and distribution facilities in the Bay Area was undertaken. It was believed such information would help point up the breadth of future development that might take place in the Bay Area. Moreover, a sample survey was felt desirable as a direct means of corroborating field findings. As plans for expansion by industry typically do not extend over periods longer than 10 to 20 years, the sample survey results are necessarily limited to the outlook for business and industrial growth over this time period.

(1) *Procedure.*—The survey was undertaken with the cooperation of the following 25 industry divisions of the Business and Defense Services Administration of the U.S. Department of Commerce:

Agricultural, Construction, Mining, and Oil Field Equipment Division
Aluminum and Magnesium Division
Automotive and Transportation Equipment Division
Building Materials Division
Business Equipment and Service Industries Division
Chemical and Rubber Division
Communications Industries Division
Construction Industry Division
Consumer Durable Goods Division
Containers and Packaging Division
Copper Division
Electrical Equipment Division
Electronics Division
Food Industries Division
Forest Products Division
General Industrial Equipment and Components Division
Iron and Steel Division
Leather, Shoes, and Allied Products Division
Metalworking Equipment Division
Miscellaneous Metals and Minerals Division
Power Equipment Division
Printing and Publishing Industries Division
Scientific, Motion Picture, and Photographic Products Division
Textiles and Clothing Division
Water and Sewerage Industry and Utilities Division

The industry divisions of the Business and Defense Services Administration are responsible for mobilization planning under authority delegated from the Office of Civil and Defense Mobilization, and they work closely with the entire U.S. industrial complex, with the exception of the petroleum, natural gas, ore and concentrates, and power-generating industries, which are handled by other Federal agencies. Because of their responsibilities and close contacts with industrial and business management, these divisions are in an excellent position to present informed opinion on the expansion plans of industry. To develop the information needed concerning the outlook for future industrial and business growth in the Bay Area, each of the 25 industry divisions was asked to provide answers or comments on the following questions:

1. What expansions by the industry represented by your Division are taking place in the Bay Area now, and what is the outlook for future expansions?

2. What are the present plans of the industry represented by your Division for locating or expanding manufacturing or distribution operations in the Bay Area in the next 5 to 20 years?

3. As population grows on the West Coast, do you expect the industry represented by your Division to increase its operations on the West Coast, and more specifically, in the Bay Area?

In providing information on these questions, the industry divisions requested that individual firm names not be reported. It was agreed that such information as size or cost of plant, amount of planned employment, general industry classification, and general comments on outlook for the future growth of the industry could be used. In view of certain limitations, not all information obtained in the survey can be included in this report.

(2) *Findings of survey.*—The results of the sample survey support the position that there will be substantial industrial and business growth, involving large increases in employment, in the Bay Area in the near future and over the next 20 years. While no precise measure of total future employment can be made on the basis of this survey of informed opinion, it can be concluded that very large increases in employment in manufacturing and distribution for the Bay Area already are being planned by industries now represented in the area and by business and industry not yet located there. The findings which follow help support this statement:

1. Two operations expect to expand employment by a combined total of 25,000 in the next 10 years.

2. One manufacturer plans, by 1965 or 1967, to build a $40 million plant providing 4,000 new jobs.

3. By 1970, one $50 million fabricating plant providing 5,000 new jobs and requiring 200 acres of land is expected to begin operations.

4. One manufacturer expects to construct an $8 million plant providing 1,000 new jobs by 1970.

5. One manufacturer plans, by 1975, to build an $18 million plant which will provide 2,500 new jobs.

6. Several major chemical and oil companies are considering the Bay Area for refineries and chemical operations. Additional refineries, petrochemical plants, fertilizer plants, plastics plants, a cement plant, a general sulphuric acid plant and the requisite supporting compressed- and industrial-gas plants, are strong possibilities for future development within and very near the Bay Area.

7. The outlook for expanding the operation of business-machine manufacturing in the Bay Area is excellent. There are now 12 major business-machine firms located in the Bay Area. Most of them expect to expand. There also are a large number of electronic firms (105 firms employing 73,000 in 1957), many of which plan to manufacture business machines. This possible shift by some electronic firms into the production of computers would mean considerable increases in employment, as much skilled manual assembly work is involved in computer production. Because the long-term future growth outlook for the electronic business-machine industry and for other electronic products is bright, these industries, already strongly established in the Bay Area, can be expected to bring about sizable increases in manufacturing employment in the future.

8. A number of industries will grow as the populations of the West and California grow. The food industry, unlike the rapid-growth industries, will expand along with but no faster than, population. A number of large food processors already are planning expanded processing and distribution facilities in the Bay Area.

9. The West Coast is a growth area for the packaging and containers field. More and more firms in this field are studying the West Coast and planning future operations there involving new facilities and plant expansions. This is because the product lines of the area are so diversified as to warrant diversified packaging services. The future growth rate of these container and packaging operations on the West Coast will exceed the national rate of growth for this industry.

10. Building material firms are expanding, and a number of firms are planning to locate on the West Coast and in the Bay Area. Continued growth of the fabricated building materials industry on the West Coast may be expected.

Another industry whose growth follows population growth is printing and publishing. This industry will grow substantially in the future in the Bay Area.

11. The furniture industry will expand at an increasing rate in the entire West Coast area. This will occur because of increasing costs of transportation and handling. In common with many other industries, there is a growing tendency in the furniture industry for retailers to rely on manufacturers' inventories and to sell only from basic samples and catalogs. To meet this situation, manufacturers will locate either assembly branches or branch factory warehouses in the selling area. Los Angeles is now the furniture center on the West Coast, but some development of the furniture industry is expected in the Bay Area.

12. Aluminum fabrication should show substantial growth on the West Coast and in the Bay Area. There is hardly enough aluminum fabrication on the West Coast to meet even present market demand.

13. The Bay Area is in a particularly strong position to share substantially in the new-product industries which will develop in the 1960's, 1970's, and later decades. The research laboratories and scientific personnel now located in the Bay Area will serve to hold engineer and technically based industries in the area and as an incubator for new products

and plants to manufacture new products. This pool of scientific and technical personnel, including university and private research facilities, represents a highly attractive force to the growth industries of the future. This asset, combined with the special amenities the Bay Area offers, should lead to the development of many new-product industries in the Bay Area in the years ahead.

14. A semi-integrated steel mill is now in operation at Pittsburg, Calif. A fully integrated steel mill located at Pittsburg is a very strong possibility within the next 5 years.

The feasibility of such an operation has been given careful study by a major steel corporation. While definite plans for construction of such a mill have not yet been announced, the proposal is under active consideration. An operation of this kind would result in the establishment of supplier and user industries in the Bay Area.

15. Such industrialization as mentioned above will stimulate development of additional, ancillary service and supplier industries; for example, tool and die shops, welding shops, and manufacturers of industrial equipment, machinery, and consumer durable goods.

In considering the above findings of this business and industry growth survey, several points should be kept in mind:

1. In a survey of this type, it is not possible to obtain information on all industries in the United States. There are many new or small industrial firms planning future expansions not known to the Federal Government.

2. Many firms will not discuss their expansion plans outside their own organizations. Therefore, such industries which may be planning operations in the Bay Area would not be represented in this survey.

3. Many of the new industries which eventually will locate in the Bay Area are not yet even in existence. Completely new products will be developed within the next 50 years. Because of the factors indicated, the Bay Area is in a strong position to obtain a share of these new products and of new industries.

In addition to information on proposed industrial construction and expansion, general comments and views of the Business and Defense Services Administration industry divisions relative to the future economic growth prospects of the West, of California, and of the Bay Area were obtained. These comments, representing the view of many industries and of Federal officials, generally support the outlook that the West, California, and the Bay Area will continue to grow much faster than the Nation and that, as the West grows, more industrial and business activity will locate there to serve the growing markets. There seemed to be wide interest exhibited by industry in the Bay Area as a location for industrial and distribution facilities. Special interest was shown in such location factors as climate and other living amenities of the Bay Area, availability of technical and scientific personnel, and the geographical location of the Bay Area as a central production, wholesaling, and servicing point for growing markets in California and the West.

As an estimate of the extent to which the sample survey supports the plausibility of projected manufacturing employment for 1970, it is noted that projected employment (see table 21) anticipates the addition of 126,000 employees in manufacturing between 1960 and 1970. If it is assumed that, by 1970, the manufacturing employment will be split 60:40 between durables and nondurables, then 75,000 of the 126,000 additional employees will be in the field of durable goods. According to the estimates in table 16, regarding minimum requirements as a basis for differentiating employment to meet local demands from employment devoted to meeting demands from outside the local area, it is found that, for urban areas of the San Francisco Bay Area size class, up to 63 percent of the workers in the durable goods area, or 47,200, will be employed to meet outside demands.

The sample survey revealed that, according to current plans, five major industrial firms in the durable-goods field expect to add about 35,000 employees to their payrolls in the San Francisco Bay Area by 1970. If one assumes that 60 to 65 percent of the output of these five major facilities is destined to meet nonlocal or "outside market" demands, then the sample survey involving only five firms may be said to have identified over half (25,000–27,000) of the 47,200 new basic or "outside market" employment between 1960 and 1970 in the durable manufactures field. In this light, it is believed that the sample survey tends to corroborate the reasonableness of the projected employment values for 1970 in the field of manufacturing.

35. Employment in Services

It is expected that about 990,000 employees will be added to employment rolls in the service industries (business, repairs, personnel, professional, and amusements) by the terminal decade, 2010–20. This is an increase in relative importance from about 21 percent in 1957 to nearly 24 percent by 2020. This overall increase of over 350 percent from 1957 to 2020 is identical with the growth rate for manufacturing. (See table 20.) Minimum requirements in this broad field (see table 18) indicate that at least 72 percent (and perhaps more) of 990,000 additional employees will be needed to satisfy service demands of the local population.

The prospect of continued expansion of employment in services is based in part upon the expectation that, as income levels rise, more disposable income will be budgeted for a wide array of business, personal, technical, and professional services, regardless of automation and the current "do it yourself" trend. As society becomes more advanced technically, the demand for professional services increases, and in the Bay Area, requirements for educational facilities and services in particular are expected to advance at an accelerated pace.

Expectation of increased service employment is based further on the belief that the Bay Area will reap a growing portion of its income from the tourist trade. One reason for optimism about the future of the tourist business in the Nation was succinctly stated recently by Resources for the Future, Inc., in its 1958 annual report (161, pp. 50–52):

> The statistics show no clear evidence of a slackening in the phenomenal growth in the use of outdoor recreation areas experienced over the last few decades. Commonsense, supported by such specialized studies as have been made, suggests that total demand for outdoor recreation is a function of the size of the population, of its per capita income, its leisure and mobility. Each of these has steadily trended upward. In Resources for the Future's study of land use, we assume for the years 1980 and 2000 a population of 240 million and 310 million; per capita income 50 percent and 100 percent higher than the present; workweeks of 32 and 28 hours; and travel on a much greater scale than at present. Perhaps even more important than actual physical travel will be psychological mobility—the existence of a large population much of which is not firmly rooted to any single community but willing to travel wherever opportunity and better living may beckon.
>
> To the best of our knowledge, the effects of population, income per capita, leisure, and mobility are multiplicative. That is, twice as many people, twice as high per capita income, half again as much travel per capita, and perhaps half again as much real leisure in 2000 as compared with the present is likely to mean something in the rough magnitude of 10 times as much total demand for outdoor recreation as now—and perhaps more. We simply do not know precisely.

This study points out also that the maximum potential demand in the year 2000 for resources-based outdoor recreation—that is, recreation offering opportunities for outdoor enjoyment, but not easily accessible to users except during their vacations—could be about 40 times greater than at present.

The Bay Area counties, especially San Francisco, and many other counties in central and northern California, are well endowed with such recreational assets, and the importance of these assets to the Bay Area counties is demonstrated by the rising volume of tourists over the past 25 years. The number of tourists has grown from an estimated 354,000 in 1932 to over 1,500,000 in 1956, according to Californians, Inc. Annual growth rates based on these estimates have varied annually from 0.3 to 0.9 percent of the national population. Extrapolation of these rates indicate that, by the year 2000, the number of tourists may well have attained a level of 7,500,000 per annum.[5]

The tourist trade in California has long had an important secondary effect in that it tends to add a direct increment to the permanent population, as is well evidenced in Florida.[6] This important byproduct of the tourist trade is expected to have a continuing effect on the growth of the Bay Area.

36. *Employment in Trade*

It is expected that by 2020 over 960,000 employees will be added to the San Francisco Bay Area employment force in retail and wholesale trade, representing a total increase of almost 320 percent. With close to 24 percent of total employment by 2020, trade will rank third—close behind manufacturing and services—in number of employees. It is estimated that by 2020, well over three-fourths of those employed in trade activities will be needed to meet the retail and wholesale requirements of the local population. (See table 18.) The balance, or something less than a fourth of the employment, which is mainly wholesale activity, will exist to meet requirements of foreign markets and markets concentrated elsewhere in northern California and neighboring counties in western Nevada. Generally speaking, however, the Bay Area's position in wholesale operations is expected to lose ground percentagewise to Los Angeles and the major urban centers in the Central Valley. The rate of growth of retailing, on the other hand, is expected to remain in step with population growth and perhaps to exceed it in selected specialty goods lines, which historically have constituted an important part of the Bay Area's trade. San Francisco's strategic central function with respect to Western States and its superior port facilities will serve the Bay Area as well in the future as in the past.

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[5] Based upon empirical trends in U.S. population and relationships between percentages of national population represented in 1946 and 1956 by tourists in the Bay Area.

[6] "It is the great promotion of Miami's tourist industry that had directly created the growth of Miami's permanent population" (152, sec. 26, p. 5).

37. Employment in Transportation, Communications, and Public Utilities

As is indicated by the projected employment for the terminal decade, employment in this element of the economy is expected to decline in relation to employment in other elements of the economy. The addition of 293,000 new employees represents a growth rate considerably below the rate for employment in all industries.

The port function of San Francisco is expected to become relatively less prominent, at least as measured by employment, although airport operations will tend considerably to offset the loss in waterborne commerce. Truck operations, too, will tend more and more to supplant railroad operations and, with all these activities, use of laborsaving devices over the years will contribute to the gradual, proportional reduction in transportation as a source of employment.

Communications will be functionally as much or more important than they are at present, but they will not be more important relatively in terms of employment. These functions will rather closely follow the requirements and growth levels of the local population.

Similarly, functions of utilities tend to follow rather than lead population growth. It is unlikely, therefore, that utilities will contribute much to offset the modest gradual decline that is expected in the relative importance of the transportation industry.

38. Employment in Government

Future demands for public services are expected to increase government employment by 335,000 by 2020. It is expected that the San Francisco Bay Area will retain its well-recognized position as the regional headquarters for many governmental, administrative, and military functions. The greatest increase in the future will be brought to this category by the addition of substantially larger numbers of employees at State and local government levels. This will follow from increasing population growth and an accompanying demand for services in such fields of public responsibility as education, health, safety, and provision of public utilities.

39. Employment in Other Elements of the Economy

The remaining major elements of the economy—construction, finance, and extractive industries—are not expected to become relatively more influential factors of local growth than they have been in the past. (See table 20.)

Employment in the field of finance, insurance, and real estate is expected to rise with overall area growth. At the terminal decade, these activities will engage about the same percentage of total employment that it engages at present.

The Bay Area will remain a headquarters and operating center for construction activities that operate throughout the world. However, the growth of this industry will continue to stem chiefly from local population growth and, as indicated by table 20, this is not expected to suffice to maintain the industry's current relative position with respect to other elements of the economy.

Agriculture and other extractive industries (mining, forestry, and fishing) are all expected to be less important in future decades. Decline in agriculture is clearly indicated, mainly because of the competition from urban land-use needs and the gradual absorption of agricultural land for residential, industrial, and similar more intensive, higher value land uses.

Chapter IV. Land for Urban Needs

PURPOSE AND METHOD

Concurrently with the projection of the probable population growth of the San Francisco Bay Area over the study period, 1960–2020, it was necessary to determine whether adequate land was available to support and maintain the anticipated population.

The amount and location of land suitable for future urban use within the study area was determined. A series of maps was constructed to indicate the probable extension of urban land during the study period, using rates that were consistent with local practice and experience, modified by previously stated assumptions on general economic growth in the Bay Area. Finally, the total areas of land use projected on the maps were checked for reasonableness against land-use totals for industrial, commercial, and residential land which were determined statistically from the projected population (see ch. II) and employment (see ch. III) by using land-use ratios adapted for this study. (For a complete description of the methods used in the land study, see app. D.) Definitions of land-use types will be found on pages D–1—D–2, appendix D.

LAND SUITABLE FOR URBAN DEVELOPMENT

In the future, a larger and larger proportion of the people in the San Francisco Bay Area will be living and working in urban communities. Of the nearly 7,000 square miles of land in the Bay Area, 3,600 square miles are physically suitable for urban development.[7] (See table 22.) Thus, for such reasons as flat or slightly rolling topography, elevation, access to other and older settled areas, and physical quality of the subsoil, slightly more than half (52 percent) of the land may reasonably be expected to be usable for urban activities. Because of location, slope, drainage, elevation, or ownership,

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[7] For a discussion of the methods used in determining land suitable for urban use, see pp. D–7—D–8, app. D.

Certain analytical problems are raised in delimiting land suitable for urban development. The definition of suitability adopted for this study was based upon local historical experience in the use of steep or poorly drained land, but relief and drainage may not, in fact, limit future use of land presently considered unsuitable, especially for residential uses. Grading, reclamation, and the willingness of users to accept extra building costs for special purposes will doubtlessly bring into use lands not considered suitable by conventional building and construction standards.

Table 22.—Developed and Potential Urban Land Supply, San Francisco Bay Area

Area	Total land area (square miles)[1]	Percent of total land area	Potential urban land (square miles)	Percent of potential urban land of total land area	Present urban development (square miles)	Undeveloped urban land (square miles)	Percent of potential urban land developed, 1958
Bay Area total	6, 976	100. 0	3, 633	52. 1	538	3, 095	14. 8
South Bay	3, 289	47. 1	1, 771	53. 8	433	1, 338	24. 4
Alameda	738	10. 6	436	59. 1	106	330	24. 3
Contra Costa	740	10. 6	587	79. 3	95	492	16. 2
San Francisco	45	. 6	40	88. 9	35	5	87. 5
San Mateo	461	6. 6	258	56. 0	98	160	38. 0
Santa Clara	1, 305	18. 7	450	34. 5	99	351	22. 0
North Bay	3, 687	52. 9	1, 862	50. 5	105	1, 757	5. 6
Marin	521	7. 5	278	53. 4	37	241	13. 3
Napa	760	10. 9	377	49. 6	18	359	4. 8
Solano	827	11. 9	560	67. 7	29	531	5. 2
Sonoma	1, 579	22. 6	647	41. 0	21	626	3. 2

[1] Includes 18 additional square miles of reclaimed land expected by 2020, distributed as follows: Alameda County, 5 sq. mi.; Contra Costa County, 6 sq. mi.; San Mateo County, 7 sq. mi.

the remaining land is less suitable for urban activities. At the present time, about 15 percent of the potentially suitable land is used for urban purposes.

Potential urban land is about evenly divided between the North Bay and South Bay counties, but the percentage of land that has been developed for urban purposes in the South Bay area greatly exceeds the percentage in the North Bay. In three counties, Napa, Sonoma, and Santa Clara, less than half of each county is physically suitable for urban development. The three counties having the largest areas of land suitable for urban development are Sonoma, Contra Costa, and Solano, in that order.

The North Bay counties have available for future development land slightly in excess of that available in the South Bay counties. About 1,800 square miles of urban land remain undeveloped in the former counties and 1,300 square miles in the latter. About one-fourth of the urban land has been developed in the South Bay, whereas only about six percent of potential urban land in the North Bay is now used for urban purposes.

Other than San Francisco, San Mateo is the most highly developed county as measured by the proportion of available urban land currently in urban use. Sonoma County, in the North Bay area, not only is the largest county in the nine-county area, but also has the largest amount of undeveloped urban land.

PRESENT LAND-USE PATTERN

The future pattern of land use in the San Francisco Bay Area will be an extension of present use and will occur at reasonable rates and in directions that can be anticipated from the multiple factors which have affected land use in the past. An examination of the present land-use pattern and the factors that influence land use provided the rationale for projecting land use over the period of the study and for construction of the land-use maps. (See pls. 11–18, plate supplement.)

40. Pattern of Settlement

The largest communities in the study area are located on or near the San Francisco Bay system and within its watershed. The present pattern of urban settlement includes a large upright letter "U" covering the lowlands around San Francisco Bay with the upper extremities at San Francisco and at Oakland-Richmond. (See pl. 11, plate supplement.) San Jose stands at the foot of the "U" near the southern end of San Francisco Bay. San Francisco and Oakland border on the deep water of the Bay and are important ocean ports. The southern extremities of the Bay are shallow, and the shores are lined with tidal marsh, much of which presently is used for extensive salt ponds. (See ch. V—Reclamation of Marsh, Tide, and Submerged Lands.)

Recent urban settlement has flowed southward from the two principal port cities, along established highway and rail routes behind the tidal marshes.

San Jose centers on a large urban area of mixed uses in the flatland south and east of the southern end of San Francisco Bay. The most active new urban development in the Bay Area is taking place between the northern limits of San Jose and the development extending from San Francisco and Richmond-Oakland, mentioned above.

On the north shore of Contra Costa County, fronting San Pablo Bay and Carquinez Strait, is a discontinuous, narrow urban strip. Urban land use is associated with the large, dispersed industrial processing plants established along this deepwater coast.

Associated with these urban cores and strip developments are numerous outlying residential areas that are dependent upon the larger cities. These include the residential areas north of the Golden Gate Bridge in Marin County, the valley cities east of the Richmond-Oakland-Hayward strip, and those along the Pacific shore south of San Francisco.

Within the counties included in this survey are several smaller agricultural centers which, although primarily dependent upon agricultural activity, do support some urban activities—including manufacturing—not associated with agriculture. Santa Rosa, Napa, and Petaluma in the northern counties and Livermore, Sunnyvale, Milpitas, and many others in the south are typical. Finally, smaller urban clusters can be found throughout the Bay Area, oriented to activities such as military installations, extractive industries, or recreation. Nearly all the agricultural and basic-activity centers are spatially separated from the major urban areas.

41. Present Land-Use Pattern

In 1958, of the land in the Bay Area classified as urban land for the purpose of this report, 538 square miles were in urban development. This land was being used for industrial, service, commercial, and residential purposes (see tables 22 and 23) and, as

Table 23.—Land Use in San Francisco Bay Area, 1958 [1]

[In square miles]

Area	Residential and commercial	Industrial	Agricultural	Public and reserved	Undeveloped and waste	Salt ponds	Total
Bay Area total	458	80	4, 378	392	1, 587	63	6, 958
South Bay	366	67	1, 963	247	581	47	3, 271
Alameda	83	23	467	73	60	27	733
Contra Costa	77	18	543	58	38	....	734
San Francisco	30	5	....	9	1	....	45
San Mateo	86	12	173	45	129	9	454
Santa Clara	90	9	780	62	353	11	1, 305
North Bay	92	13	2, 415	145	1, 006	16	3, 687
Marin	33	4	370	55	59	....	521
Napa	17	1	435	5	290	12	760
Solano	25	4	657	27	110	4	827
Sonoma	17	4	953	58	547	....	1, 579

[1] As measured by planimeter (see p. D-8, appendix D).

previously noted, included 15 percent of the area's total potential urban land. In the South Bay area, about 1 acre in 4 of the urban potential had been developed; this contrasts sharply with the North Bay area, where only 1 acre of every 18 potential urban acres had been put to urban use by 1958. San Francisco County, which is coterminous with the city of San Francisco, is almost completely developed at the present time. (See table 22.)

In the South Bay area, excluding San Francisco, San Mateo is the most intensively urbanized county. More than one-third of the potential urban land in that county is now in urban development. Urban development in Alameda County is the most extensive, covering 106 square miles. This was about equal to the sum of all developed urban land in the North Bay counties in 1958. Contra Costa County is the least developed in the South Bay area, with about 95 square miles, or 16 percent, of the 587 square miles of potential urban land in the county presently in urban use. (See table 22.)

In the North Bay area, there is a sharp contrast among the four counties between land presently in urban use and the potential available for urban purposes. Marin County is the most extensively developed of the North Bay counties, with more than 13 percent of its urban potential land developed. Each of the remaining three northern counties, Napa, Solano, and Sonoma, had used less than 6 percent of its respective available urban-land potential by 1958. Less than 4 acres of every potential 100 urban acres had been developed in Sonoma. (See table 22.)

The pattern of industrial land extends through five counties in the South Bay area and accounts for over 80 percent of all the industrial establishments in the Bay Area. (See table 23.)

In 1958, in the Bay Area, 80 square miles of land were in industrial use. (See table 23, and pl. 11, plate supplement.) The largest concentration of such land—23 square miles, or more than one-fourth of the Bay Area total—is in Alameda County. The amount of industrial land in Alameda is nearly twice the total of all industrial land in the four northern counties.

Industrial land use in the Bay Area typically is concentrated in narrow strips along lines of transportation. In San Francisco County, a solid development extends from the Marina east of the Presidio southward along the waterfront to Hunters Point. On the Peninsula south of San Francisco, in San Mateo County, industrial land lies on the flat back of the Bay shore, but the overall pattern is discontinuous along the transportation routes, with nuclei at large urban centers. Industry is concentrated on the land between the urban strip and the Bay and between the railroad and the Bayshore Freeway. Most of the industry in this area is grouped in what are basically industrial districts.

Beginning directly south of Redwood City, industrial land is randomly spaced to San Jose, where it again forms a more or less solid narrow strip along the railroads to the center of the city. On the fringes of San Jose, industrial land use is scattered and continues in this manner northward around the Bay through Fremont and Hayward to San Leandro, where it again becomes a solid strip. This industrial concentration continues along the railroad on into Oakland, Emeryville, and Berkeley. The industrial pattern is solid from the port of Richmond along the railroad through San Pablo to Pinole Point. East of Pinole Point, the industrial land-use pattern on the north shore of Contra Costa is irregular to the Delta area. The land parcels of the large primary industries along the deepwater shoreline are generally big in size and in many cases are perpendicular to the deepwater estuary and the Santa Fe and Southern Pacific Railroads that parallel the coast. These land parcels are generally large in comparison with the narrow strip development along highways elsewhere in Contra Costa and Alameda Counties.

The present predominance of the South Bay area in the development of urban land and industrial land is repeated in the area's residential and commercial land. Total land area in the South Bay used for these purposes is four times that in the North Bay. (See table 23.) The proportion of total urban land presently used for residential, commercial, and industrial purposes is about the same in the two sections. Eighty-eight percent of all urban land in the North Bay is residential and commercial; such land in the South Bay occupies 85 percent of all urban land. Napa County has the smallest acreage of urban land in industrial use of all counties in the Bay Area.

Agriculture is the largest single type of economic land use in the Bay Area. (See table 23.) Nearly 4,400 square miles, or 63 percent of all land, is presently used for all agricultural purposes. In this category, the North Bay area has about 23 percent more acreage than does the South Bay area. The agriculture land-use category includes the extremes of grazing land with low per-acre productivity and irrigated cropland which yields high gross values per acre.

A substantial amount of land in the Bay Area, nearly 400 square miles, is publicly owned or reserved for various purposes which preclude development for private urban uses in the foreseeable future. Throughout the Bay Area, urban expansion has been arrested or redirected by these reserved lands. This use often restrains the pace and direction of urban growth more than topography.

For example, military reservations and parks restrict the further westward expansion of San Francisco. Similarly, south of San Francisco on the Peninsula, urban expansion westward has been stopped by the reserved watershed lands. Further growth of urban lands in Palo Alto has thus far been arrested by the extensive Stanford University property; however, portions of this "reserve" are now being opened to residential and commercial development. The effect of this type of reserved land has been to add impetus to the general southward expansion and filling-in process. San Jose is not bounded by contiguous reserved lands, and this, perhaps, is a contributing factor to the irregular land-use pattern in that area.

In the East Bay, Berkeley, Oakland, and San Leandro all have expanded eastward to the reserved watershed lands. On the other hand, Hayward, which is not backed by reserved lands, has expanded farther eastward toward Castro Valley. In the Concord area, urban expansion in the Clayton Valley has extended to the Concord Naval Ammunition Depot. Benicia, across Carquinez Strait, is nearly surrounded by an arsenal.

In the Bay Area, approximately 1,600 square miles, or about 23 percent of the total land area, is in undeveloped or waste land. (See table 23.) Wasteland is defined as rugged or scrub land characterized by steep mountain ridges and rough, unusable slopes at high altitude; moor or marshlands which are separated from urban areas and not likely to be reclaimed over the study period; and steep coastal slopes paralleling the Pacific.

42. Present Land Use and Present Population

Although the several Bay Area counties vary greatly in size, the total land area is about evenly divided between the North and South Bay areas. (See table 24.) The total amount of potential urban land also is about evenly divided between the North and South Bay areas.

The availability of suitable land has had little effect on population distribution up to the present time. More than 85 percent of the present Bay Area population is located in the South Bay counties. Only about 15 percent of the population is located in the North Bay counties, yet the North Bay counties have slightly more than half of the available potential urban land.

When the percentage of potential urban land in each county is divided by the percentage of population for that county, a ratio is obtained which is a convenient measure of relative county urban development potential. (See table 24, col. G.) It can be seen that there is a large disparity between current population of the counties and their land supply as a proportion of the Bay Area total. If ranked by this method from maximum to minimum development possibility for future population, the counties line up in the following order: Napa, Solano, Sonoma, and Marin in the North Bay area, and Contra Costa, Santa Clara, San Mateo, Alameda, and San Francisco in the South Bay area. (See table 24, col. H.)

Table 24.—Comparison of Present Population With Potential Urban Land

Area	1958 population[1] (A)	Percent of Bay Area population (B)	Area (square miles) (C)	Percent of total land area (D)	Potential urban land (square miles) (E)	Percent of potential urban land (F)	Development ratio, col. F to col. B (G)	Rank of ratios in col. G (H)
	Thousands							
Bay Area total	3,492.7	100.0	6,976	100.0	3,633	100.0	....	....
South Bay	3,022.2	86.5	3,289	47.1	1,771	48.7	0.56	....
Alameda	886.8	25.4	738	10.6	436	12.0	.47	8
Contra Costa	370.4	10.6	740	10.6	587	16.1	1.52	5
San Francisco	791.1	22.6	45	.6	40	1.1	.05	9
San Mateo	399.1	11.4	461	6.6	258	7.1	.62	7
Santa Clara	574.8	16.5	1,305	18.7	450	12.4	.75	6
North Bay	470.5	13.5	3,687	52.9	1,862	51.3	3.80	....
Marin	136.8	3.9	521	7.5	278	7.7	1.97	4
Napa	63.5	1.8	760	10.9	377	10.4	5.78	1
Solano	125.5	3.6	827	11.9	560	15.4	4.28	2
Sonoma	144.7	4.2	1,579	22.6	647	17.8	4.24	3

[1] "California Population in 1958", Department of Finance, Budget Division, Financial Research Section, Sacramento, July 1958.

As noted elsewhere, the largest counties have the largest areas of land suitable for future development. Again, however, actual size is not the only consideration. Accessibility is probably a much more important factor than is the physical suitability of the land. For example, Sonoma is the largest county in size, and it also has the largest area of flat and gently sloping land. Nevertheless, Sonoma is at present the least developed of the nine counties. (See table 22.)

With the exception of the Santa Rosa plains—an area of some 25,000 acres of flat or gently sloping land—the land pattern in Sonoma County consists of flat and rolling land in the bottoms of several long, narrow valleys, and comparatively isolated side valleys, almost basinlike in character, separated by rugged, mountainous areas. These same characteristics are observable in Napa and Solano Counties, although not to the same degree as in Sonoma. The eastern parts of Alameda, Contra Costa, and Santa Clara Counties and the Pacific slopes also could be described as being too rugged and isolated, with comparatively poor transportation and communication, soon to attract a sufficient number of persons to occupy the available land at relatively high density.

PHYSICAL FACTORS AFFECTING FUTURE LAND USE

The 60-year projection of land use in the San Francisco Bay Area was made by shaping the anticipated, periodic expansion of the present industrial, residential, and commercial uses described above (see table 23) on the available and suitable urban land previously delimited, and by applying historical trends observed in land-use patterns near large metropolitan centers. In the following paragraphs, descriptions of these trends in the San Francisco Bay Area are included to illustrate the reasoning used in developing the future land-use pattern. It is impossible, however, to list all of the qualifications that helped determine the location of the land-use boundaries over the projection period. The locations of these boundaries, especially those that go beyond or differ from the usual 25–30-year estimates made by local planning commissions, are based on examination of local data, estimates, and information supplied by local informants. In most cases, the projected land-use pattern reflects local consensus; in other cases, projected boundaries are "composites" of the reasons discussed below which were modified by expert local opinion where this was available.

43. The Landscape Base

The Bay Area comprises a variety of landscape features. A series of valleys and hill or mountain ranges paralleling the Pacific Coast is cut through by the most conspicuous of the Bay Area's physical features—San Francisco Bay and its associated water bodies, including the Golden Gate and the Delta of the Sacramento and San Joaquin Rivers.

Existence of this superb deepwater harbor on the "Western Coast of the continent provides the only explanation necessary to justify the location of a great city in the region" (165). The land immediately adjacent to the port south of the entrance to the harbor provided space for the initial settlement of San Francisco. Early concentration of the various urban forces in the region in this central location helped maintain the dominance of San Francisco over other areas which have continued to share a relative role to the central city based on strictly local advantages. Oakland and other port cities developed on the Bay shore where topographic conditions permitted.

The intervening north-south valleys between the mountain ridges provide sites for extensive urban settlement and agriculture and the necessary connecting transportation facilities. Settlement occurs at intersections of these settlement corridors, at breaks in transportation (railway-ferry, highway-railway), or in agricultural areas, to provide service and collection facilities.

In each county there is at least one long, narrow expanse of gently sloping alluvium, either in a valley between two mountain ranges or on a bayside coastal strip backed by foothills and mountains. Each county, other than San Francisco, also has an extensive area of tidal salt marsh bordering San Francisco Bay, San Pablo Bay, or Suisun Bay. Napa County does not border the Bay, but tidal salt marsh is found within its boundaries.

Industries are extremely sensitive to transportation accessibility, slope of land, load-bearing quality of subsoils, size of plot, proximity to employment, utilities, and other location factors. Suitability of a particular site within well-established limits may be improved in quality by grading, filling or piling, clearing, and construction. Nevertheless, costs for improvement probably will limit future industrial development to the extension of presently developed lands and the development of detached sites where the combination of site factors make the project economically feasible.

The land area for extensive industrial use will be limited to areas of 5-percent slope or less with adequate bearing capabilities. (See pl. 10, plate supplement.) Industrial use of such lands with low relief will occur where extension of public services is provided along major transportation routes. Reclaimed land in limited amounts will be used for industry where load-bearing factors are suitable for those industries which can absorb the high cost of reclamation.

Not all industry is located on flatland. Extractive industries such as quarries and sandpits are located at natural deposits. Other industrial operations such as petroleum storage can use steep or sloping land. Small plants in small buildings are not dependent on gentle slope or large, level parking areas and can take advantage of centrally located plots regardless of physical quality.

Physical qualities of site are much less critical for residential or commercial land than for industrial land. The land suitable for residential and commercial development is, therefore, much greater in extent than that suitable for industry, and residences, in turn, can be built on land not suitable for stores. The desirability of a commercial site will be dependent upon the transportation facilities which serve it and its association with the market area and related commercial activity.

Many of the qualities which make land suitable for urban use also are important to agriculture. Gentle slope, adequate drainage, and central location are attributes of good agricultural land as well as qualities sought by residential-tract developers and large dispersive industry. It was assumed that, in the absence of legal restrictions such as zoning ordinances,[8] industrial, commercial, and residential uses would be able to surpass any economic competition from agriculture for use of these prime lands.

The only current instance where the effect of climate on urban land use is apparent and was considered in the projection of land use was with reference to the coastal fog, which until recently has retarded residential development on the Pacific Coast slope. Smog on the East Bay shore south of Oakland may modify the development of upper grade dispersed settlement behind the East Bay cities during the early part of the study period; however, it is probable that this impediment to development will virtually be eliminated by effective smog control measures toward the latter part of the period.

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[8] In the farming area north of San Jose is an interesting example of an attempt by farmers to meet the competition of tract development through zoning methods (194).

44. *Public Utilities*

Availablity of an adequate water supply is critical to the use of land in the Bay Area for both industrial and nonindustrial uses. This is particularly true of suburban areas in the southern counties and in areas affected by salinity in the western portion of the Delta of the Sacramento-San Joaquin Rivers. The historical and often critical use of ground water in many areas for domestic and industrial purposes has been relieved by the progressive importation of water from outside the region. However, groundwater supplies continue to be overdrawn in Alameda and Santa Clara Counties, principally for agricultural use.

The California State Water Resources Board, commenting on the supply of water available, summarized the supply problem in the Bay Area as follows (11, p. 82):

> The principal water problems of the San Francisco Bay Area result from rapidly increasing population, together with intensification of agricultural activities and expanding practice of irrigation. In general, the requirement for water to meet the urban phase of this problem has been met by increased importations and by development of local supplies through construction of new surface storage works. Since World War II, nearly every major water service agency has increased its storage or conveyance facilities in order to satisfy demands for service. Despite these increases in facilities, the available water supply has barely kept pace with the demand.
>
> Growing agricultural water requirements have been met largely by increased ground water pumpage, which in several localities has introduced the previously mentioned problem of ground water overdraft. The effects of overdraft have been experienced in lowering of water tables and degradation in quality of ground water.
>
> The possibility of damage from floods has always existed in certain portions of the San Francisco Bay Area, but the expansion of residential development along the bay shores and into areas of reclaimed marshland has aggravated the problem of flood damage and control. Much of the residential development which took place in the relatively dry seasons of 1947, 1948, and 1949, without sufficient consideration being given to drainage, was subjected to flooding in the wetter seasons of 1950, 1951, and 1952.
>
> * * * Future development in the San Francisco Bay Area will depend in large measure upon fulfillment of the increased water requirements for all purposes.

This land-use study presumed that public utilities, including water, power, and sewerage, would be available when and where needed, although utilities would not be available immediately in all parts of the Bay Area. Extensions of public utilities would be made from existing facilities as development of industrial and residential uses followed in related progression from presently developed lands to contiguous new-development areas. In a few instances, the installation of a large, dispersed, industrial establishment may make possible the development of a parcel detached from existing facilities. However, the large capital funds needed for development of sewage disposal and water supply usually delay the use of isolated land unless such utilities can be economically justified.

45. *Accessibility and Transportation*

Land use in the Bay Area historically has been oriented to transportation, and it is presumed that future land use also will reflect the use, extension, and modification of the transportation network. In projecting land use, the highway and railroad provided the basic framework. Industry in the future will continue to be oriented to transportation, and, where both highway and railroads are available, the chances of future industrial growth are more certain. Residential and commercial areas also are dependent on access to sources of employment. This distribution will influence and will be influenced by the extension of major traffic arteries.

In building up the subsequent land-use patterns by decades, improvements in the mass-transportation network were anticipated. The present railway pattern seems fixed, at least for freight, and thus for industrial uses. The development indicated in the projection is based on the assumption that an extensive mass-transportation system would be provided in the future (30). In making the land-use projections, it was not considered necessary to solve one of the basic problems of whether or not commutation would be to central work areas or to highly localized neighborhood work areas. In either case, the residential areas will be built up for the expected population growth and would be related to industrial use of land.

Major improvements are expected in the development of superhighways in the study area. (See pl. 1, plate supplement.) A freeway system being planned by State authorities indicates the improvements which might be expected to come first. For purposes of this study, extensions of these plans to the end of the study period had to be presumed. These roads will supplement the existing transportation pattern and will extend the development of residential uses to areas that are now relatively remote from existing urban centers. These major roads and the assumed mass-transportation network provide the backbone for local plans for the future.

Typical of the major highway improvements considered were the completion of the Eastshore Freeway, in the East Bay area, extending from Crockett in Contra Costa County to San Jose in Santa Clara County, and the recent completion of U.S. Highway 101 Bypass on the Peninsula, extending from San Francisco to San Jose. Studies are underway for a second East Bay, north-south expressway along the tidelands of Alameda County, extending from Alameda to Newark. Studies are underway also for two additional north-south highways on the Peninsula: The Junipero Serra Freeway route west of U.S. Highway 101, for which plans have been adopted, extending from Daly City to San Jose; and a freeway on the tidelands of San Mateo and Santa Clara Counties, east of U.S. Highway 101 Bypass, extending from San Francisco to San Jose. The latter route has not been adopted pending further study.

Improvements were anticipated also in Alameda County in the Crow Canyon route from Niles through Sunol Canyon to Danville and on Route 50 to Tracy through the Livermore Valley. Various other route improvements suggested in planning proposals, as well as other plans of the California State Highway Department, were considered.

New or additional water crossings are being provided at Martinez across Carquinez Strait, and were presumed for the future across the Sacramento River between Antioch and Collinsville. A new Bay crossing south of San Francisco, as well as a second overwater route to Marin County via Tiburon Peninsula, were presumed.[9]

The future pattern of transportation within the Bay Area will continue to influence the differential development within the counties. The relative isolation resulting from the absence of through rail service, particularly in Sonoma and Solano Counties, will hinder the development of heavy industry there. The relative transportation advantages of the South Bay counties will help to maintain a continuing dominance of industry and population in that area.

In summary, it has been presumed that transportation in the future will be largely an extension of and improvement on the present pattern. Thus, land-use changes will be adapted to the improvements and extension of the transportation network.

46. Other Factors

Master land-use plans and controls, recreation needs, and other public requirements will influence the use of land in the future. In projecting the land-use patterns, the master plans, where available, were used. It was presumed that planning for use of land would find increasingly greater acceptance so that there would be a continuous trend to incorporation of the built-up area and application of an agreed-upon zoning procedure with locally effective controls, with a more orderly growth resulting over the period of the projection. Increasing pressure on the county plans will come with population growth and will doubtless generate increasing interest in and support of these plans.

LAND-USE PATTERNS: 1958-2020

The anticipated future changes in land use within the San Francisco Bay Area are described in this section and are illustrated in the series of land-use maps. (See pls. 11 through 18, plate supplement.) The first projection and corresponding map cover the period from 1958 to 1960; the succeeding projections and maps cover 10-year periods. The sequence of changes in the pattern of land use over the study period reflects the influence of the various local factors described above applied at differential local rates which are consistent with the expected growth of population and industry. Reasons for a local change in the land-use boundaries are given in many instances, but it was not possible to cover all reasons in detail.

This study is a description of what land-use changes may reasonably be expected if future land needs as indicated by population and economic projections are met, and if past land-use practices and trends continue over the study period. The study is not a blueprint of the land-use patterns that might be desirable.

In the discussion that follows, the term "urban land" refers to the total of residential, commercial, and industrial land as listed in the table for each period and as shown in two classes on the land-use maps. (See pls. 11–18, plate supplement.) All places named are located on the orientation map. (See pl. 1, plate supplement.)

The 1960 land-use map (pl. 12) incorporates the developments in urban land that had been planned or announced before the conclusion of the field examination in 1958. These included plans for new industrial facilities and for the housing and commercial services needed by the anticipated growth in population. Most of these expansions were projected on present agricultural lands. There will be some transfers from nonagricultural land to urban land, such as in San Mateo County along the western Bay shore, but these changes are insignificant within the total transfer figure.

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[9] These suppositions should not be interpreted as endorsement by the Office of Area Development for any particular type or exact location of these crossings.

47. Changes in Land Use to 1960

In the 2-year period there will be an increase of about 18 square miles in industrial land and 60 square miles of residential and commercial land. With only minor exceptions, this expansion will be made on agricultural land, which will decline by about 78 square miles. (See table 25.) Alameda and Santa Clara Counties will show the largest increases in urban land during the 2 years following 1958. In the North Bay area, greatest urban growth will occur in Solano and Sonoma Counties.

The largest change in a single category of land use between 1958 and 1960 will be the transfer of agricultural land to urban uses. The change is particularly noticeable in the flat, agricultural lands in San Mateo, Santa Clara, and southern Alameda Counties, although this growth is occurring on the outskirts of every city and town in the Bay Area. The changes include individual plot or parcel development, separate subdivisions, and additions to existing subdivisions.

The extension of urban use onto agricultural land in the southern counties on both sides of the Bay has been accompanied by growth perpendicular to the main line of southward growth. The lateral extensions often are expansions of existing centers onto agricultural or formerly vacant lands.

For the next few years, growth in the North Bay counties will comprise contiguous extensions of present use and will be much more compact as compared with growth in the South Bay counties. "Scatteration," which consists of intensive residential tract developments generally well separated from other similar tracts, is not as marked in the North Bay as it is in the South Bay. There is relatively little evidence of extensive continuation of urban sprawl, with one exception—the southern tip of Marin County. Extension of urban and residential uses will continue, however, sectorlike along the main highways, or spokewise from existing, denser settlement of county towns and small urban centers.

In Solano County, there will be considerable expansion around the center of Vallejo and a tendency toward coalescence of Benicia and Vallejo. The beginnings of scatteration and later development of a solid, urban center will occur near Green Valley and Cordelia. There will be further urban sprawl in the Suisun-Fairfield area, also in Solano County, and in the area in Marin County immediately north of San Rafael along the main highway north to Novato.

Table 25.[1]—Projected Land Use: San Francisco Bay Area, 1960

[In square miles]

Area	New urban land	Residential and commercial	Change from 1958	Industrial	Change from 1958	Agricultural	Change from 1958
Bay Area total	78	518	+60	98	+18	4, 300	−78
South Bay	61	414	+48	80	+13	1, 902	−61
Alameda	18	97	+14	27	+4	449	−18
Contra Costa	14	89	+12	20	+2	529	−14
San Francisco	0	30	0	5	0	....	....
San Mateo	10	94	+8	14	+2	163	−10
Santa Clara	19	104	+14	14	+5	761	−19
North Bay	17	104	+12	18	+5	2, 398	−17
Marin	3	36	+3	4	0	367	−3
Napa	3	20	+3	1	0	432	−3
Solano	5	27	+2	7	+3	652	−5
Sonoma	6	21	+4	6	+2	947	−6

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[1] In tables 25–31, on projected land use within the study area, the increases of certain uses (primarily residential and commercial, and industrial) were not balanced against decreases in other uses (primarily agricultural). It is assumed that the most extensive change will be from agricultural to urban use. However, it is to be expected that there will be other changes, i.e., residential to industrial, residential to public use, wasteland to residential or industrial uses, etc., which will make up a complex pattern of division and change. Since the land-use projection is in fact a design of gross dimension, it was considered impracticable to "balance out" the gains and losses between the several classes of land use.

Daly City, immediately south of San Francisco, has recently expanded westward to the ocean. Large-scale residential development now occupies both former vacant land and former grazing land. On the ocean, the Edgemar and Sharp Park areas in San Mateo County are expanding onto cultivated crop and grazing land as well as onto former vacant land.

On the Bay side of the Peninsula, South San Francisco, San Bruno, Millbrae, and Burlingame, southward to the Mountain View-Los Altos area, are expanding westward to the crest of the ridges and eastward onto the tidelands. Where industrial parks have been established, both residential and industrial uses have replaced agriculture and occupied vacant land. A similar land-use pattern is found on the east side of San Francisco Bay, where urban development has extended up to the crest of the hills paralleling the Bay. Contiguous development stops at Hayward, where the expansion seemingly has bent around the end of the reserved lands and extended eastward to Livermore Valley.

There are two areas with the greatest potential for immediate urban development. These are the Fremont area in Alameda County and the San Jose-Los Gatos-Los Altos triangle in Santa Clara County. The physical and economic characteristics of these two areas—rather flat, gently sloping, valley land, well serviced by transportation and utilities and adjacent to recent industrial and residential development—point up prime investment and development opportunities.

On the East Bay side there will be a filling-in of the Newark area, with extension of residential development southward along the main highways south of Hayward toward Decoto and Niles and north from Irvington and Mission San Jose in Alameda County. In Contra Costa County, the recent, rapid growth near Concord will continue, particularly down the Clayton Valley and the Ygnacio Valley, east of Walnut Creek, down the San Ramon Valley, and along the industrial highway south of Martinez. The Broadway Tunnel will still be a positive growth factor in the suburban fringe of Oakland, through Orinda and Lafayette toward Walnut Creek, especially so if its capacity is expanded as presently projected.

48. Changes in Land Use to 1970

Urban development in the 1960–70 period will continue the suburbanization trend anticipated in the period before 1960. Land closest to existing development which had been held idle prior to 1960 will be put in urban use, and some potential industrial land near urban centers will be developed. In a few instances, industrial land will spill over onto residential land and, in some outlying areas, onto agricultural land. In this period, filled tidal marshes will still be unattractive for industrial purposes except in a few unusual cases.

By 1970, land in urban use (residential, commercial, industrial) will total about 813 square miles, an increase of 32 percent from 1960. (See table 26 and pl. 13.) Much of this growth, 118 square miles, or nearly 60 percent of the Bay Area total, will take place in the South Bay counties. Santa Clara County presumably will have the greatest urban

Table 26.—Projected Land Use: San Francisco Bay Area, 1970

[In square miles]

Area	New urban land	Residential and commercial	Change from 1960	Industrial	Change from 1960	Agricultural	Change from 1960
Bay Area total	197	689	+171	124	+26	4, 069	–231
South Bay	118	515	+101	97	+17	1, 777	–125
Alameda	36	128	+31	32	+5	417	–32
Contra Costa	34	119	+30	24	+4	487	–42
San Francisco	0	30	0	5	0	....	....
San Mateo	11	104	+10	15	+1	154	–9
Santa Clara	37	134	+30	21	+7	719	–42
North Bay	79	174	+70	27	+9	2, 292	–106
Marin	29	63	+27	6	+2	352	–15
Napa	6	25	+5	2	+1	380	–52
Solano	28	51	+24	11	+4	620	–32
Sonoma	16	35	+14	8	+2	940	–7

growth in terms of area, although urban land in Alameda and Contra Costa Counties will increase by about the same amount. Most of the increase in urban land will take place on agricultural land, which will decrease by 231 square miles during the period. About two-thirds of the increase in industrial land will occur in the South Bay area, with the greatest increase in Santa Clara County.

On the west side of San Francisco Bay, there will be continuing encroachment on the remaining vacant lands between the Bay and the San Bruno Mountains, and many of the smaller, isolated housing developments in that area will coalesce. This consolidation of local residential settlement will take place also on the Pacific slope of the San Brunos.

The area around Half Moon Bay will develop into a solid strip north past Pillar Point and beyond Half Moon Bay airport. The isolated areas of Pescadero, San Gregorio, La Honda, and Portola will be expanded outward but still will remain rather remote from the main stream of growth in the Bay Area. There will be rapid growth in the area south of Redwood City and immediately west of the Dumbarton Bridge.

On the east side of the Bay there will be continued growth in the Fremont area and coalescence of the many smaller towns such as Newark, Irvington, Decoto, and Niles. There will be continued growth in the Livermore area and coalescence of some of the scattered nuclei in that area but, in general, the growth here will lag behind the growth in the Newark-Fremont area, where accessibility to San Francisco and Oakland gives it a distinct advantage over Livermore.

Growth from Sunnyvale south through San Jose toward south Santa Clara County will continue. Extension of urban land in large, uninterrupted subdivisions on level land as in the past will give way to development of smaller parcels on the rougher land in the southern area of the county. South of San Jose near Edenvale, the settlement pattern is interrupted by rough land, but at San Martin additional compact development is expected toward Gilroy. The triangular area between Los Altos, Los Gatos, and San Jose will be filling in rapidly in this period, and agricultural land in this area will rapidly be disappearing.

In Contra Costa County, the Walnut Creek-Concord area will have been developed into an essentially continuous urban area by 1970. In central Contra Costa County, Clayton Valley will be wholly developed, and the San Ramon Valley and Stone Valley, extending east from Alamo, will by this time be almost completely occupied by residential development. Presumably, the Ygnacio Valley, also in Contra Costa County, will now be connected by a major highway to the Clayton area, and a string of developments will line this new route. Martinez and Walnut Creek will coalesce, and many of the scattered subdivisions will have grown to the point where they may be considered satellite towns of cities that were themselves formerly satellites of the larger metropolitan cities. There will be considerable growth in the northern part of Contra Costa County, where the increase of heavy industrial activity along the Sacramento River will be generating growth to the Pittsburg area. Pittsburg likely will have grown and surpassed Port Chicago in extent. In this area, as elsewhere, there will be continuing encroachment on the good agricultural land adjoining the city limits. By 1970, the major lines of growth in the north Contra Costa area will be fairly well indicated, and future growth will be largely an expansion of extensions already indicated in the present pattern.

In Solano County, Vallejo and Benicia will have combined and considerably expanded. The Green Valley development and Cordelia will now have grown together. Suisun and Fairfield will have grown to a sizable center, and there will be scattered urban development along the main route to Sacramento.

A new bridge across the Sacramento River at Martinez, connecting with Benicia, will help stimulate development in the Napa Valley because of added accessibility. There will be an expansion of urban land use up the Napa Valley with a peripheral expansion of Napa, itself. The separate settlements in Napa Valley north to St. Helena will be adding new growth.

Marin County, as a whole, will continue its rapid growth, and the southern part of the county, north of the Golden Gate Bridge, will have coalesced into a continuous urban area.

In Sonoma County, Petaluma, Sonoma, and isolated developments along the highways toward Santa Rosa will show additional growth. By this time, Santa Rosa will be showing the general effects of urban sprawl in a wide, level valley far removed from the major Bay Area centers. By 1970, Santa Rosa will be a major urban center.

49. Changes in Land Use to 1980

There will be continued growth along the main arteries of communication and continued coalescence of isolated developments into contiguous urban areas. (See pl. 14.) The encroachment of urban and other nonagricultural uses onto agricultural lands will continue in all of the counties as the competition for use of level land intensifies. The isolated settlements in the northern and eastern counties will continue to grow.

By 1980, residential communities will be firmly related to industrial and other job-producing activities. Presumably, there will be a regular hierarchy of urban development branching out from the cultural-regional character of the main cities, San Francisco and Oakland, down through the small, isolated communities; the latter will be self-contained and dependent upon local employment either in new industry or in indigenous materials processing.

During this decade, urban land will increase by 239 square miles—209 residential and commercial and 30 industrial. (See table 27.) The largest share, 142 square miles (116 residential and commercial and 26 industrial), will be developed in the South Bay area. Industry will continue to favor the southern counties, where about one-fifth of all new urban land will be used for industrial purposes. In the northern counties, only about 4 percent of the new urban land will be used for industrial purposes, the remainder being used for residential and commercial uses. Agriculture will decline significantly during this period and in about the same amount as the increase in new urban land.

By 1980, the continued growth and population increase in the South Bay counties will have pushed the development of urban land closer to the limit of dispersed settlement. All the land suitable for urban development in the northern part of San Mateo County will be occupied by urban activities, and the only nonurban areas remaining will be at the top of the San Bruno mountain ridge, most of which presumably will be part of a regional park or reserved land. The Pacific side of the county will be developed completely to San Pedro Point, and there will be extensions of residential development north and south along the ocean shore from Half Moon Bay.

Table 27.—Projected Land Use: San Francisco Bay Area, 1980

[In square miles]

Area	New urban land	Residential and commercial	Change from 1970	Industrial	Change from 1970	Agricultural	Change from 1970
Bay Area total	239	898	+209	154	+30	3, 846	−223
South Bay	142	631	+116	123	+26	1, 652	−125
Alameda	34	155	+27	39	+7	388	−29
Contra Costa	41	156	+37	28	+4	446	−41
San Francisco	1	30	0	6	+1	....	....
San Mateo	16	115	+11	20	+5	148	−6
Santa Clara	50	175	+41	30	+9	670	−49
North Bay	97	267	+93	31	+4	2, 194	−98
Marin	28	91	+28	6	0	330	−22
Napa	18	43	+18	2	0	367	−13
Solano	16	66	+15	12	+1	597	−23
Sonoma	35	67	+32	11	+3	900	−40

Reclamation of Brewers Island will have been completed, and the fill along the Brisbane Cutoff will have added considerable industrial land to San Mateo. Many of the detached communities in the remote southwestern part of the county will develop into residential communities, with La Honda and Portola becoming independent centers.

In Santa Clara County, Sunnyvale and Palo Alto will be united with San Jose, Los Gatos, and Edenvale into a single urban complex. San Martin, Morgan Hill, and Gilroy will show continued development along the southern expressways. By this time, there probably will be a second main highway along the length of the valley, continuing the East Bay Highway beyond Alum Rock. This new highway will tend to pull development eastward and to elongate development north and south along the new route.

In Alameda County, the numerous separate neighborhoods in the Fremont area will have coalesced by 1980 into a single center, and there will be development on reclaimed marshlands to the west and into the hills to the east. The east side of the Bay will be completely developed up to and through Hayward and Castro Valley, with some extension toward Dublin on present Route 50 and toward San Ramon on the Crow Canyon route. Pleasanton, Sunol, Dublin, and Livermore will continue to grow with the coalescence of existing subdivisions and the development of new ones. There will be continuous and solid development in many of the valleys of former isolated sections.

East of Oakland, Alameda, and Berkeley, the last remaining vacant land up to the boundary of the reserved land will have been occupied. Some of the East Bay Municipal Utility District lands will have been developed for residential use. Urban development will be solid between Concord and the Concord Naval Ammunition Depot. Clayton Valley will be completely developed, while strip development will border the highway from Clayton to Antioch.

With few exceptions, the north shore of Contra Costa County will be completely developed with industrial, residential, and commercial uses. By 1980, Port Chicago will have grown together with West Pittsburg, Pittsburg will again have expanded considerably, and strip development between Pittsburg and Antioch will be near coalescence into a continuous development between these two centers.

The type of continuous development of large urban tracts apparent in the South Bay counties will not yet have occurred in the North Bay counties. Individual communities in these latter counties will continue to expand in local, radial patterns, although there will be some development along the main connecting routes. In Solano County, Vallejo and Benicia will have grown together, while there will be extensive development on the Vallejo-Napa axis. The Cordelia and Green Valley area will have expanded northward, with new industrial plants giving the area a more compact and self-contained character. The same will be true of the Fairfield-Suisun area and of the Vacaville and Elmira areas. The Dixon area will be starting to grow at this time, and the route between the Bay Area and Sacramento appears to be one of the main areas of sustained growth.

Napa will continue to grow, with consolidations or filling-in between many of the areas in Napa County that previously had been independent local centers. By 1980, St. Helena will have grown into a separate regional urban center.

The small centers of Boyes Spring, Glen Ellen, and Kenwood in Sonoma County will have coalesced in a continuous development with some new industrial activity. Petaluma will have developed new industrial land with accompanying residential development and will be extending southward along the main route between San Francisco and Santa Rosa.

In Marin County, Novato, Ignacio, Fairfax, San Rafael, and San Anselmo will form one continuous urban development. The assumption is that Belvedere and Tiburon Peninsula will be developed partly as a result of a new North Bay crossing via Angel Island. On the Pacific side of Marin, some of the resort areas will now have developed into permanent residential communities.

50. Changes in Land Use to 1990

By the decade ending in 1990, the South Bay area will be characterized by a great urban agglomeration ringing San Francisco Bay and extending into the nearby valleys and along the Pacific shore. (See pl. 15.) The gross urban pattern based on a skeletal framework of transportation will show up clearly in the urban land south of San Francisco and Oakland, setting the stage for increased settlement in the North Bay area to accommodate the continued growth of population in the Bay Area as a whole.

The amount of new urban land, 243 square miles, will be about the same as that added during the previous decade. (See table 28.) In the South Bay, Contra Costa will have added 9 square miles of new industrial land to double the figure added over the 1970–80 decade. New urban land in San Mateo County will be primarily residential and commercial. In the North Bay, the predominance of new residential and commercial land development over industrial land development will continue.

Expansion of industrial land will be slowing down in San Mateo, and increases of urban land in the South Bay will be taking place in the eastern sections of Contra Costa and Alameda Counties.

In the Peninsula area, San Mateo County will be solidly developed down the Pacific Coast beyond Half Moon Bay, with some scatteration through Pescadero down the shore to Santa Clara County. On the eastward slope of the coastal hills, a solid area will extend from Woodside to the county line, paralleling the county line southward to Portola Road.

The San Jose area will be built up south to New Almaden and beyond, while the eastern fringes of San Jose will have pushed on beyond the circumferential highway and Alum Rock Park.

Milpitas and Warm Springs will coalesce solidly with Irvington, eastern San Jose, and with the Fremont area in general. This general area on the east side of the Bay probably will be the location of most significant urban growth in the Bay Area to 1990. The area around Newark and Alvarado will expand its residential and industrial uses, and there will be some reclamation for urban uses in the East Bay marshlands. Inland, the Livermore Valley will be almost solidly urban at this time. The basic urban pattern will have crystallized from Hayward to Altamont and from Dublin northward through the San Ramon Valley to Danville and Walnut Creek.

Table 28.—Projected Land Use: San Francisco Bay Area, 1990

[In square miles]

Area	New urban land	Residential and commercial	Change from 1980	Industrial	Change from 1980	Agricultural	Change from 1980
Bay Area total	243	1, 112	+214	183	+29	3, 705	−141
South Bay	165	768	+137	151	+28	1, 565	−87
Alameda	33	181	+26	46	+7	375	−13
Contra Costa	43	190	+34	37	+9	428	−18
San Francisco	0	30	0	6	0	....	....
San Mateo	31	144	+29	22	+2	135	−13
Santa Clara	58	223	+48	40	+10	627	−43
North Bay	78	344	+77	32	+1	2, 140	−54
Marin	18	109	+18	6	0	314	−16
Napa	12	55	+12	2	0	359	−8
Solano	27	92	+26	13	+1	587	−10
Sonoma	21	88	+21	11	0	880	−20

The Concord-Walnut Creek-Clayton area will be solidly developed. Pittsburg and West Pittsburg will have coalesced with Port Chicago on the west and with Antioch on the east. Antioch will have grown to the south and east to meet extensions from Oakley and Brentwood and toward new scattered development near Byron.

It is presumed that a bridge will have been constructed in the Antioch or Pittsburg area, making another cross-bay connection. As a result, sizable growth will occur in Solano County in the Collinsville-Birds Landing area and near Rio Vista. Vallejo and Benicia will have coalesced and expanded to the east. Extensions of Vallejo northward will now meet the extension southward from Napa. Cordelia will have begun to sprawl outward to the south and to the west, continuing its growth eastward to Suisun and Fairfield and northward toward the county line. The Fairfield-Vacaville-Elmira area will be almost solidly developed, and Dixon will be affected by expansion from both Sacramento and San Francisco.

The Napa Valley will show almost solid development north of Yountville. Urban development of Sonoma will again have solidified and expanded northwestward so that the development almost coalesces with Santa Rosa. Santa Rosa in the same time will have grown rapidly, extending southward to the northernmost end of the Kenwood area. Santa Rosa also will have expanded to include Cotati, extending westward beyond Sebastopol and northward to Forestville. Urban characteristics will be developing in Geyserville and Cloverdale and the area of Rio Nido, Guerneville and Monte Rio along the Russian River, as well as Jenner at the mouth of the Russian River, and Fort Ross to the north. Coming south to Marin County, Bodega Bay, Marshall, Point Reyes Station, Inverness, Olema, Nicasio, and points between Point Reyes and Petaluma will have developed to a point where they have independent urban character. Novato and Petaluma will be on the verge of coalescence, while Lagunitas, Fairfax, Nicasio, Bolinas, and Stinson Beach will have more or less solidified.

51. Changes in Land Use to 2000

In 2000, San Mateo County will be largely a continuous development practically all the way from San Francisco south to San Gregorio. (See pl. 16.) There will be a noticeable filling-in west of the reserved lands in the San Francisco Water District and near Pescadero and behind the hills of the Los Altos-Portola area. South of Woodside, urbanization will have advanced onto hilly land with a scattering of subdivisions below the county line toward Santa Cruz on the coast. This area is a single stem extension from San Jose, separated from the movement southward from San Jose toward Gilroy.

These general trends of urban expansion will continue to the turn of the century. There will be no significant changes in the pattern of growth, and the increment of urban land will continue in all counties except San Francisco, largely as a result of conversion of agricultural lands to urban uses. (See table 29.) The urban land area will be twice as large as four decades earlier.

Table 29.—Projected Land Use: San Francisco Bay Area, 2000

[In square miles]

Area	New urban land	Residential and commercial	Change from 1990	Industrial	Change from 1990	Agricultural	Change from 1990
Bay Area total	220	1, 295	+183	220	+37	3, 431	−274
South Bay	164	901	+133	182	+31	1, 392	−173
Alameda	30	201	+20	56	+10	351	−24
Contra Costa	43	224	+34	46	+9	378	−50
San Francisco	0	30	0	6	0	...	...
San Mateo	25	165	+21	26	+4	101	−34
Santa Clara	66	281	+58	48	+8	562	−65
North Bay	56	394	+50	38	+6	2, 039	−101
Marin	4	113	+4	6	0	296	−18
Napa	4	58	+3	3	+1	336	−23
Solano	33	122	+30	16	+3	562	−25
Sonoma	15	101	+13	13	+2	845	−35

The pressure on lands of low relief in the South Bay will increase. In San Mateo and Santa Clara, new industrial land will replace what formerly was residential land, and residential developers will be using steeper land and land which today would be considered too remote and inaccessible for urban use.

Santa Clara County will continue to develop more urban land than any other county and more than the entire North Bay during the same period.

On the east side of the Bay, there will be continuous, solid development through the Newark area and through Hayward to Castro Valley. The eastern part of Alameda County, including the Dublin, Pleasanton, and Livermore Valley areas, will now be solidly coalesced with the developments below San Ramon and Danville.

The Antioch-Brentwood-Oakley area will be a solid string or elongated development containing small isolated farming areas. New subdivisions will be scattered in the extremely rough area immediately to the west of Martinez and between Martinez and Port Costa.

In the North Bay area there will be an increase in new industrial land, most of it in Solano and Sonoma Counties. Solano will show the largest urban growth among the North Bay counties.

Rio Vista in Solano County will have developed into a large, outlying center. The Collinsville and Birds Landing areas will have coalesced, with industrial establishments lining the Southern Pacific Railroad.

There will be discontinuous ribbon urban development along the highway between Fairfield and Rio Vista.

The main line of development in Solano County along the highway and along the railroad northeast of Fairfield will now be continuous through Dixon. Vacaville, Fairfield, and Elmira will have merged with Cordelia, while between Cordelia and the extensions of Vallejo there will be a discontinuous string of isolated, separate, residential developments. From Vallejo northward to Napa, there will be a continuous, solid, urban development extending to Yountville, St. Helena, and Calistoga.

In Marin County there will be solid development spreading into adjacent Sonoma County to and beyond Petaluma. The Sebastopol, Cotati, and Santa Rosa triangle will be developing generally along the same lines as the area between the Santa Clara-Sunnyvale-Los Gatos triangle and Los Altos. Healdsburg, Cloverdale, and Geyersville in northern Sonoma County will continue to grow, with a new center developing at Alexander Valley. Between Point Reyes Station and Petaluma, two centers will be developing: Nicasio merging with Lagunitas and Fairfax, and Olema-Point Reyes Station-Inverness merging to form a new complex in the extreme reaches of Marin County. Bodega Bay, at this time, probably will have developed into a sizable town, and expansion of the adjacent park area together with the contemplated State university will contribute to local economic expansion.

52. *Changes in Land Use to 2010*

By 2010, the increase in urban land as a percentage of total urban land in the North Bay, 30.2 percent, will be nearly twice the percentage in the South Bay, 17.0 percent. (See table 30.) It is probable that this increasing difference in rate between the two sections will continue, because large acreages of undeveloped land will be available only in the North Bay counties.

Table 30.—Projected Land Use: San Francisco Bay Area, 2010

[In square miles]

Area	New urban land	Residential and commercial	Change from 2000	Industrial	Change from 2000	Agricultural	Change from 2000
Bay Area total	408	1, 669	+374	254	+34	3, 175	−256
South Bay	221	1, 101	+200	203	+21	1, 263	−129
Alameda	45	240	+39	62	+6	318	−33
Contra Costa	49	268	+44	51	+5	323	−55
San Francisco	0	30	0	6	0	....	....
San Mateo	52	213	+48	30	+4	87	−14
Santa Clara	75	350	+69	54	+6	535	−27
North Bay	187	568	+174	51	+13	1, 912	−127
Marin	23	134	+21	8	+2	292	−4
Napa	23	80	+22	4	+1	324	−12
Solano	61	178	+56	21	+5	515	−47
Sonoma	80	176	+75	18	+5	781	−64

The basic pattern of land use in the study area will be well established in 2010, reflecting the local land resources available for urban support and expansion. (See pl. 17.) The extension of land use down the Peninsula, in the coast area, and in the Bay side of San Mateo will leave little of the available potential urban land undeveloped. The remaining land will comprise extremely steep and rough topography useful only for grazing or special public use. Nearly all the marshlands in San Mateo County will be reclaimed. In western Santa Clara County along the north-south transportation lines there will be local filling-in of the urban area south to the county line. In Alameda, there also will be local filling-in, with continued encroachment of urban land on the marshlands and continued coalescence with the areas to the east through Crow Canyon.

In Contra Costa County there will be continued expansion within the three main north-south valleys and east and south of Antioch through Brentwood down to Byron.

In Solano County, Rio Vista, Collinsville, and Birds Landing all will have expanded, with continuation of the lineal pattern along the Sacramento highway. The same will be true of the routes between Vallejo and Napa as well as of that between Schellville through Kenwood to Santa Rosa. Extending from Novato, in Marin County, there probably will be a continuous urban strip into Sonoma County through Santa Rosa to Sebastopol, Forestville, and north to the Russian River.

In western Sonoma and Marin Counties there will be development of smaller centers such as Valley Ford, Tomales, Bodega, Bodega Bay, Jenner, and Fort Ross.

53. Changes in Land Use to 2020

The increasing rate of urbanization of the North Bay will continue in the period ending in 2020. (See table 31.) In the period 1960–70 (see table 26), about three-fifths, or 60 percent, of the growth was assumed to have occurred in the South Bay. In the period 2010–20 (see table 31), only 52 percent of the growth will have taken place in the southern counties. The largest increase in urban land among all counties in this and the preceding decade will take place in Sonoma County, where there are still extensive areas of suitable land of low relief and where the radiating growth influence of San Francisco and Sacramento merge and amplify each other.

Table 31.—Projected Land Use: San Francisco Bay Area, 2020

[In square miles]

Area	New urban land	Residential and commercial	Change from 2010	Industrial	Change from 2010	Agricultural	Change from 2010
Bay Area total	466	2, 079	+410	310	+56	2, 810	−365
South Bay	240	1, 303	+202	241	+38	1, 060	−203
Alameda	73	299	+59	76	+14	256	−62
Contra Costa	71	327	+59	63	+12	274	−49
San Francisco	0	30	0	6	0	....	....
San Mateo	31	240	+27	34	+4	58	−29
Santa Clara	65	407	+57	62	+8	472	−63
North Bay	226	776	+208	69	+18	1, 750	−162
Marin	33	166	+32	9	+1	254	−38
Napa	44	122	+42	6	+2	298	−26
Solano	57	225	+47	31	+10	459	−56
Sonoma	92	263	+87	23	+5	739	−42

By 2020, there will be almost contiguous development throughout the nine Bay Area counties. (See pl. 18.) The major portions of the main valleys will be solidly developed, and more isolated parts of the Bay Area, particularly the southern counties, will have begun to feel some of the outward impact stemming from the central cities and from nearby cities in the Central Valley and south of the study area. The easternmost portion of Livermore Valley may have felt some impact from the growth around Tracy. The Dixon area will be affected by the growth radiating from Sacramento.

It is anticipated that, by 2020, the land area devoted to urban activities will total nearly 2,400 square miles. (See table 32.) By that time, nearly two-thirds of the land suitable for urban uses will so be used. Most of the suitable land in the South

Bay counties will be used for industrial, commercial, and residential purposes, and agricultural land will be confined to more remote and isolated localities or to patches of orchard, truck crops, and dairying. The South Bay area will be one large urban agglomeration based on the low-lying lands between the ridges and the Bay, with fringes of urban use extending into the valleys, especially along the through highways and the railroads.

Major changes that will appear in 2020 include the filling-in of the San Mateo County coastline below Pescadero and extensive growth around Ano Nuevo Point. There will be a continuous urban development from Gilroy, in south Santa Clara County, up to Santa Rosa in Sonoma County, and from San Francisco to the San Joaquin County line and north to the Yolo County line northeast of Dixon.

Table 32.—Urban Land in Use, San Francisco Bay Area: 2020

Area	Potential urban land (table 24)	Developed urban land 2020 (table 31) [1]	Percent potential urban land developed by 2020
	Square miles	*Square miles*	
Bay Area total	3, 633	2, 389	65. 8
South Bay	1, 771	1, 544	87. 2
Alameda	436	375	86. 0
Contra Costa	587	390	66. 4
San Francisco	40	36	90. 0
San Mateo	258	274	(2)
Santa Clara	450	469	(2)
North Bay	1, 862	845	45. 4
Marin	278	175	62. 9
Napa	377	128	34. 0
Solano	560	256	45. 7
Sonoma	647	286	44. 2

[1] Urban land equals the total of residential, commercial, and industrial land. (See discussion, pp. 62–63, and table 31.)

[2] Exceeds 100 percent of potential urban land (30 percent or less slope; see p. D-7, app. D).

Livermore Valley will be completely integrated with the development stretching southward from Oakland. Byron and Brentwood will be connected to the urban mass, while sizable developments in the Collinsville and Rio Vista areas will be solidly established. In the North Bay, development in the Napa Valley will be completely contiguous, but large patches of agricultural land will remain. The area from Healdsburg north to the Sonoma County line will be almost completely contiguous. The Inverness, Olema, and Point Reyes Station area will be solidly connected to the Fairfax, Ignacio, Novato, and San Rafael complex. The Bolinas and Stinson Beach area will be connected through the San Andreas Rift Valley with Olema and Point Reyes Station. Between Point Reyes Station and Petaluma, sizable centers will be developing at local crossroads. Schellville will have become an integral part of the Sonoma-Napa complex. Vallejo, Napa, and Cordelia will be part of a contiguous development with the exception of the surrounding agricultural areas.

AVAILABILITY OF URBAN LAND IN 2020

By 2020, nearly 2,400 square miles or about 65 percent of the more than 3,600 square miles of potential urban land in the Bay Area will be in urban use.

Urban development will be approaching the limit of available land in the South Bay, and the stage will be set for the accelerated expansion of the North Bay area. In two counties, San Mateo and Santa Clara, suitable urban land as defined earlier in this chapter (see footnote, p. 55) will be fully occupied by urban functions, and further expansion of urban uses will be taking place only on slopes of more than 30 percent and in filled land along the Bay shore. There will be changes in use of land within the urban category. Presumably, residential land will be changing to industrial or commercial land while, in some instances, industrial land may change to residential or commercial land as in the case of urban renewal projects. Certainly there will be increases in the density of urban use. For example, multifamily housing projects will replace single-family homes, particularly in central areas.

In 2020, there will be no vacant land in San Francisco available for development for urban purposes. More than 85 percent of the available urban land in the South Bay area will be developed, and throughout the southern counties efforts will be made through grading and filling to bring more marginal land into use. By contrast, the North Bay counties will still have land available for urban development and, as the pressure for land grows in the southern counties, future urban development may be expected to increase in Napa, Solano, and Sonoma Counties. In Solano County, however, urban pressures from the Central Valley will be increasing, and the outward push of the Sacramento suburbs will be felt along the San Francisco-Sacramento highway route.

By 2020, there still will be a large amount of reserved land remaining in the Bay Area, as well as a large acreage of land in agriculture and sizable areas of reclaimable marshland. (See ch. V.) Many of the steeper slopes and wooded areas that could support extensive use, or in some instances even intensive use, will as yet be untouched.

From these projections it would appear that the amount of land available for urban use will accommodate the population that is projected for the Bay Area, and that the amount of urban land is adequate for the special land uses required for the support and servicing of that population. In fact, adequate urban land will be available within the nine-county study area for urban needs beyond the period covered in this report.

Chapter V. Reclamation of Marsh, Tide, and Submerged Lands

INTRODUCTION

54. Scope

The location and extent of reclaimable marsh, tide, and submerged lands, as well as some of the problems of reclamation, are pertinent to any study of future land use in the San Francisco Bay Area, to any estimates of future water needs, and to a critical consideration of proposals for the construction of barriers in San Francisco Bay.

In this chapter, past reclamation in the Bay Area is examined, the cost factors of reclamation are analyzed, and an attempt is made to determine how much reclamation in the Bay Area can be expected to take place in coming years. The information in this chapter will be further expanded in the Corps of Engineers survey report. Results of an investigation by the U.S. Department of Agriculture on certain reclaimed lands in the Bay Area and the agricultural potential of lands presently submerged will be included in that report. Additional information on methods and costs of reclaiming marsh, tide, and submerged lands will be developed by the Corps of Engineers. (See Foreword.)

55. Definitions

For the purposes of this report, the following definitions of marsh, tide, and submerged lands are used: "Marshland"—land lying between mean high tide and 5 feet above mean sea level; "tideland"—land lying between mean high tide and mean low tide; "submerged land"—land lying below mean low tide. These definitions follow those given in a report of the State of California Department of Public Works (226, app. D).

The U.S. Coast and Geodetic Survey charts for the Bay Area give depths of water in relation to mean lower low tide. In San Francisco and San Pablo Bays, this level is 1.10 to 1.20 feet below mean low tide; in Suisun Bay, it is 1.07 feet below at Benicia, and 0.70 foot below at Chipps Island. Thus the area shown on these charts between mean high tide and mean lower low tide is greater in extent than the area defined as tide lands.

56. Names of Water Bodies in the Bay Area

According to the U.S. Coast and Geodetic Survey, the lines separating the bodies of water in the Bay Area, as set forth below, are in no sense legal boundaries, but are based on physiographical considerations and on past and present chart and map usage. (See pl. 19, plate supplement.)

(*a*) *San Francisco Bay-San Pablo Bay.*—There is general agreement that these two bays are separated by a line from Point San Pedro to Point San Pablo.

(*b*) *San Pablo Bay-West End Carquinez Strait.*—Here there is a difference in historical and current usage. Historically, these two bodies of water are separated by a line from the southwestern extremity of Mare Island to Davis Point. At each of these points there is a definite change in the direction of the coast. In present navigational practice, the dividing line is placed a little farther eastward, from the eastern entrance point of Mare Island Strait southward to the vicinity of Selby. For practical purposes, this distinction does not seem important. The only important questions seem to be whether Mare Island is wholly within San Pablo Bay and whether Mare Island Strait and Napa River are tributary to San Pablo Bay or Carquinez Strait. A decision of the U.S. Geographic Board in its sixth report of 1932 (215) describes Napa River as flowing into the strait, while numerous other authorities hold that it flows into San Pablo Bay.

(*c*) *Carquinez Strait and West End of Suisun Bay.*—Here there is general agreement that the dividing line is from Army Point to Bulls Head Point. The U.S. Geographic Board decision for Bulls Head Point (215) describes it as "at entrance to Suisun Bay."

(*d*) *East End of Suisun Bay.*—For this boundary, there is definite disagreement. The historical origins and both past and present usage by all agencies having to do with navigation (Coast and Geodetic Survey, Coast Guard, and Corps of Engineers) place the eastern limit of Suisun Bay at the confluence of the Sacramento and San Joaquin Rivers. This concept is due to the original character of the "bay," which in the early days included all the marshy islands and waterways south of the present Montezuma Slough. Diking and drainage of much of this area have altered the original character of the bay. As a result, a decision by the U.S. Geographic Board (215) describes the San Joaquin River as flowing into the Sacramento River 4 miles east of Suisun Bay. Maps published by the U.S. Geological Survey (with the exception of several at the very earliest dates) follow this same idea. This means that the waterway approximately 4 miles long between Point San Joaquin and the line Simmons Point-Stake Point is part of the Sacramento River, and that the line Simmons Point-Stake Point is the eastern limit of Suisun Bay. For practical purposes, the principal difference is the location of the town of Pittsburg and navigation in New York Slough.

In 1957, the U.S. Board on Geographic Names considered this last conflict in name application. It did not issue a new decision but rather reaffirmed the former decision in the sixth report for San Joaquin River (215), which definitely considered this 4-mile stretch of water, south of Van Sickle and Chipps Islands, as part of Sacramento River. While this ruling was subject to further representations by the State of California, thus far none have been made.

(*e*) *South End of San Francisco Bay.*—The natural limit is a line from Calaveras Point to Long Point. Decisions of the U.S. Board on Geographic Names describe both Guadalupe River and Coyote Creek as flowing into the south end of San Francisco Bay. The light near Calaveras Point is listed by the Coast Guard under the heading of San Francisco Bay. Some authorities place the southern end of the bay at the narrow strait between Ravenswood Point and Dumbarton Point, but the former limit is believed preferable. The 1953 USGS Mountain View quadrangle map has the name "San Francisco Bay" south of latitude 37°30′.

57. Basic Data and Literature

In order to obtain accurate estimates as to what cost ranges can be anticipated for various types of reclamation projects, the Office of Area Development surveyed 10 reclamation projects in the Bay Area which have been completed since 1938. Results of this survey are discussed later in this chapter. (See pp. 85–86.)

Preparation of a bibliography of maps, reports, surveys, and other materials pertaining to the reclamation of marsh, tide, and submerged lands in the Bay Area was the first step in the study of reclamation.

Federal agencies such as the Bureau of Reclamation, U.S. Department of the Interior; the Corps of Engineers, U.S. Army; the Bureau of Yards and Docks, U.S. Department of the Navy; and various State and local planning agencies were contacted for information on the location of reclamation projects in the Bay Area. From these sources were obtained data on past reclamation projects, projects currently under construction, and those planned for the future. Reclamation projects were identified cartographically and then examined by aerial reconnaissance and ground observation. Additional data on acreages involved, cost of reclamation, time of construction, and future plans were obtained from reclamation contractors and others operating in the Bay Area.

Published data on reclamation in the San Francisco Bay Area were supplemented by information obtained through personal interviews with individuals having knowledge of area reclamation problems.

58. Maps

To illustrate past reclamation activity in the Bay Area and the current status of reclamation, two detailed maps were prepared. (See pls. 19 and 20, plate supplement.) Plate 19 shows the historical pattern of reclamation in the Bay Area between 1850 and 1958. (For discussion, see pp. 78–84.) Plate 20 shows the present use of lands that have been reclaimed. (For discussion, see pp. 87–88.) These maps are based on various published reports, charts of the U.S. Coast and Geodetic Survey, land-use maps of local planning units, and field observations.

A special annotated section of the bibliography (see app. E) is devoted to reclamation, with particular emphasis on materials dealing with reclamation in foreign lands where construction problems are similar to those found in the San Francisco Bay Area. This section, entitled "Reclamation Bibliography," includes pertinent articles published since 1930 listed in the "Engineering Index," the catalogs of the Library of Congress, and other basic sources.

59. Reclamation Methods Employed in Bay Area

The two principal methods of reclaiming marsh, tide, and submerged lands are levees with drainage, and fill. Reclamation by levees with drainage is usually accomplished by construction of major and secondary levees to protect the reclaimed area against tide and flood waters and of drainage ditches for the collection of surplus water within the area. This water is either pumped out of the enclosed area or drained by gravity through tidal gates. Reclamation for salt production differs only slightly. In this case, levees are constructed to close the area against flooding by tidal waters and to form the ponds in which the saline water is evaporated.

Both dry fill and hydraulic fill are used in the Bay Area. Dry fill is applied in one of two ways. In one technique, fill is placed as a blanket on marsh or submerged lands to compress the underlying material. In some instances, a retaining dike is constructed around the perimeter of the fill. In the second method, the weight of the fill serves to displace the underlying mud. To accomplish this, overloading is practiced at the front of the fill, the mud thus displaced forming a wave which moves outward as the fill progresses. This method was used in creating the latest addition to the San Francisco International Airport and in the fill for the Bayshore Freeway from Candlestick Point to Sierra Point.

Most large reclamation projects in the Bay Area involving hydraulic fill have used sand for fill material and rock for the retaining dike. A few small reclamation projects, mostly in creeks and small bay areas, have used mud or silty mud for both the dike and the fill. After the hydraulic fill has been permitted to dry out and settle for a year or more, it is covered by a dry fill to a depth of about 3 feet.

As a method of reclamation, the filling of marsh, tide, and submerged lands has been subject to some changes. In the past, several places in the San Francisco Bay Area were reclaimed by the construction of levees high enough to keep out tidewaters, and the areas behind the levees were filled to levels below the tops of the levees. The practice today is to fill the area to be reclaimed to such a height that frequent inundation will not occur from flood or tide waters.

The counties and many of the cities in the Bay Area now have ordinances that require filling to a height substantially above mean sea level for fills on marsh, tide, and submerged lands adjacent to the three bays. These minimum requirements are given in table 33. Existing elevations for freeways in the Bay Area are given in table 34.

Table 33.—Required Minimum Elevations in Feet Above Mean Sea Level for Fills on Marsh, Tide, and Submerged Lands Adjacent to San Francisco Bay, San Pablo Bay, and Suisun Bay [1]

Area	Residential land	Industrial land	Public land	Street crowns	Top of curbs
Alameda County:					
Bay Bridge to San Lorenzo	9.0	9.0	9.0	9.0	9.0
San Lorenzo to Dumbarton Bridge	9.5	9.5	9.5	9.5	9.5
South of Dumbarton Bridge	10.0	10.0	10.0	10.0	10.0
Contra Costa County:					
West portion	7.0	7.0	7.0	7.0	7.0
East portion	9.5	9.5	9.5	9.5	9.5
Marin County	7.0	7.0	7.0	7.0	7.0
Napa County	9.0	9.0	9.0	9.0	9.0
San Francisco County	8.62	8.62	8.62	8.62	8.62
Santa Clara County:					
Mountain View	...	8.0	8.0	...	9.0
Sunnyvale	...	9.0	9.0	(2)	(2)
San Jose	10.0	10.0	10.0	...	10.0
Alviso	...	...	[3] 10.0	...	...
Palo Alto	7.5	7.5	(4)	(4)	5.0
San Mateo County	7.0	7.0	7.0	...	7.0
Solano County	9.0	9.0	9.0	...	9.0
Sonoma County	2 to 3 feet above high tide.[5]				

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[1] Furnished by the San Francisco District, based upon information received from the counties.

[2] As required by specific conditions.

[3] Pertains to school lands.

[4] Requirements vary from 0 to 5.5 feet.

[5] Mean higher high water averages 3.2 feet above mean sea level for Sonoma County.

Material used for filling may be placed by a dredge operating in the immediate area of the fill or dredged elsewhere and transported to the site of the fill. Also, the fill may be excavated as dry material—rock or earth—and transported by various means to the site of the fill. If dredging is practiced, a dike, usually of rock, is constructed in order to confine the dredged material to the area of the fill.

If the material on which the dike is to rest proves unstable, it may be necessary to remove considerable quantities of this material and back fill with more stable material. Not all material is suitable for fill, and the material used depends upon a number of factors, among which are the characteristics of the underlying material, the availability of suitable fill materials (both from a physical and an economic point of view), and the intended use of the reclaimed land.

Table 34.—Existing Elevations for Freeways in San Francisco Bay Area

Location	*Elevation in feet above mean sea level*
Alameda County:	
U.S. 40 at Hearst Ave., Berkeley	7. 1
U.S. 40 at Ashby Ave., Berkeley	6. 2
Calif. 17 at High St., Oakland	6. 1
Calif. 17 at East Cr. Slough, Oakland	5. 0
Calif. 17 at Hegenberger Rd., Oakland	7. 5
Calif. 17 at Landing Rd	6. 6
Marin County:	
U.S. 101 at Richardson Bay Bridge	7. 1
San Mateo County:	
U.S. Bypass 101 at Harbor Blvd	7. 2
U.S. 101 at Hillsdale	7. 3
U.S. 101 at 16th Ave	5. 7
U.S. 101 at Poplar Ave	3. 3
U.S. 101 at Airport Interchange	6. 3
U.S. 101 at Candlestick Fill	14. 7

Source: California State Highway Department.

60. Reclamation in Foreign Lands

The reclamation of marsh, tide, and submerged lands in other countries was achieved by techniques similar to those employed in the San Francisco Bay Area. Substantially all sites for port facilities, industrial facilities, housing, commercial developments, and airports were reclaimed by filling. Both hydraulic and dry filling were used for these purposes. Land for less intensive use, primarily for agricultural purposes, was reclaimed in the foreign areas reviewed by construction of levees and subsequent drainage.

Whereas in the Bay Area the need for more salt ponds has led to the greatest [10] amount of reclamation by means of levees and drainage, in foreign areas the need for food products has been the most significant factor. A review of the literature indicates that port development accounts for much of the land reclaimed by filling in other countries. Another major consideration leading to reclamation in foreign countries has been the need for transportation facilities, especially for airport sites.

Reclamation in the Netherlands, particularly the closing of the Zuider Zee and the forming of a fresh-water lake (IJsselmeer) from which land is being reclaimed, has attracted worldwide attention. Population pressure, a rise of the salt-water table due to large and increasing withdrawals of fresh water, as well as considerations of safety during periods of high tides and storms, have led to large-scale reclamation projects. Reclamation in the Netherlands is distinctive in the large areas of tide and submerged lands reclaimed from the sea, and in the complex engineering problems involved. The projects are resulting in the acquisition of substantially more agricultural land, and in new supplies of fresh water to combat salinity. Filling is practiced in the Netherlands on a large scale for such more intensive uses as the expansion of port facilities.

RECLAMATION IN THE BAY AREA—1850–1957

61. Early Reclamation

Reclamation in the San Francisco Bay Area started as a result of two events: the discovery of gold in California in 1848; and the passage of the Swamp and Overflow Act by the U.S. Congress in 1850. The discovery of gold, which brought ships carrying people and goods to San Francisco, created a need to develop port facilities. The Federal Swamp and Overflow Act and acts passed by the State of California provided for title to the marsh and tidelands to be passed to private individuals, with the provision that these lands be reclaimed for agricultural use.

62. Bases of Data

The delineation and measurement of reclaimed and reclaimable areas discussed in this section are based on comparisons of U.S. Coast and Geodetic Survey Nautical Charts, Basic Sheets, Nos. 5531, -32, -33, -34, and periodic revisions of these sheets dating from 1859 to 1942; on analyses of land-use maps prepared by local planning agencies in the Bay Area; and on field observations made in 1957.

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[10] A greater area is used for recreation purposes, but part of this is, at times, intentionally flooded for duck-hunting purposes. (See table 37.)

For determination of the marshlands existing prior to the beginning of reclamation in 1850, charts published by the U.S. Coast and Geodetic Survey between the years 1850 and 1862 were used. A careful check of all marsh areas indicated no appreciable differences between the areas identified on the charts and the areas delineated by the 5-foot contour line. Tidelands have been defined on page 75. Submerged lands available for reclamation are considered to extend about to the edges of the deeper channels. (See also p. 90).

63. *Areas Reclaimed*

The total land area originally available (in 1850) for reclamation in the San Francisco Bay Area amounted to 568.2 square miles. (See table 35.) Marsh, tide, and submerged lands reclaimed in the San Francisco Bay Area today total 242.8 square miles, more than two-fifths of the total area originally available for reclamation. Nearly all this is reclaimed marshland, which totals 226.1 square miles, or 93 percent of the reclaimed land. Thus, of the total of 303.7 square miles of marshland available for reclamation in 1850, nearly three-fourths have already been reclaimed. The remaining 77.6 square miles lie scattered throughout the Bay Area, mostly around Suisun Bay. (See pl. 21, plate supplement.)

Table 35.—Reclamation of Marsh, Tide, and Submerged Lands in the San Francisco Bay Area: 1850–1957

[In square miles]

Area	Total	San Francisco Bay proper	San Pablo Bay	Suisun Bay
Lands available for reclamation in 1850, total	568.2	259.8	175.9	132.5
Marshland	303.7	98.4	94.2	111.1
Tide and submerged lands	264.5	161.4	81.7	21.4
Lands reclaimed to 1957, total	242.8	94.8	72.8	75.2
Marshland	226.1	78.4	72.5	75.2
Tide and submerged lands	16.7	16.4	0.3	.....
Lands susceptible of reclamation in 1957, total	325.4	165.0	103.1	57.3
Marshland	77.6	20.0	21.7	35.9
Tide and submerged lands	247.8	145.0	81.4	21.4

Sources: U.S. Coast and Geodetic Survey Nautical Charts Nos. 5531, -32, -33, -34; land-use maps prepared by local planning agencies; and field observations, 1957.

Only 16.7 square miles of tide and submerged lands have been reclaimed since 1850. Therefore, the possibilities for future reclamation lie largely in the class of the tide and submerged lands, with close to 250 square miles still available. (See table 35 and p. 90.)

Table 36 shows the amounts of land reclaimed in various periods, and the rates of reclamation as average amounts of land reclaimed per year.

64. *Definitions of Bays*

In table 38 and the following discussions, the term "three bays" means the water area of all the bays—Suisun, San Pablo, and San Francisco Bay proper. By San Francisco Bay proper is meant that part of the system lying between San Pablo Bay in the north to the Alviso area in the extreme south.

Local custom considers South San Francisco Bay as the waters of San Francisco Bay proper south of the Bay Bridge. However, because of distinctly different physical conditions, different types of reclamation, and present land use, San Francisco Bay proper has been divided into a Northern Section and a Southern Section by a line drawn from Point San Mateo (in San Mateo County) to the southern tip of Bay Farm Island near San Leandro (in Alameda County).

65. *Rates of Reclamation*

The annual rate of reclamation in the Bay Area as a whole has increased steadily from 1.6 square miles in the period 1850–1900 to 3.6 square miles in the 1940–57 period. (See table 36.) The progress of reclamation has not been the same in each of the area's three bays. Peaks of activity have occurred at various periods of time. In Suisun Bay, the highest activity was reached in the years 1900–1925, when an average of 0.9 square mile of land was reclaimed annually. The peak of activity in San Francisco Bay proper occurred during the period 1925–40. In San Pablo Bay, two periods of activity are noted: First, from 1900 to 1925; and second, from 1940 to 1957. During the intermediate period, only a negligible amount of reclamation was accomplished.

Table 36.—Progress of Reclamation of Marsh, Tide, and Submerged Lands in the San Francisco Bay Area: 1850–1957

Area	Total Reclaimed Area, 1850–1957		1850–1900		1900–25		1925–40		1940–57	
	Area (square miles)	Rate (square miles per year)	Area (square miles)	Rate (square miles per year)	Area (square miles)	Rate (square miles per year)	Area (square miles)	Rate (square miles per year)	Area (square miles)	Rate (square miles per year)
Bay Area, total	242.8	2.3	77.6	1.6	59.9	2.4	43.4	2.9	61.9	3.6
San Francisco Bay	94.8	.9	14.4	.3	6.7	.3	40.6	2.7	33.1	1.9
Northern section	36.4	......	5.5	......	6.7	......	10.9	......	13.3	......
Alameda County	15.1	......	1.2	......	3.8	......	5.1	......	5.0	......
San Francisco and Upper San Mateo County	12.8	......	3.0	......	1.8	......	5.0	......	3.0	......
Marin County	5.2	......	1.3	......	(1)	......	......	......	3.9	......
Contra Costa County	3.3	......	......	......	1.1	......	.8	......	1.4	......
Southern section	58.4	......	8.9	......	(1)	......	29.7	......	19.8	......
West shore	34.3	......	2.0	......	(1)	......	15.9	......	16.4	......
East shore	24.1	......	6.9	......	......	......	13.8	......	3.4	......
San Pablo Bay	72.8	.7	20.5	.4	29.8	1.2	.6	(1)	21.9	1.3
North and west shores	72.5	......	20.5	......	29.6	......	.5	......	21.9	......
Southeast shore	.3	......	......	......	.2	......	.1	......	......	......
Suisun Bay	75.2	.7	42.7	.9	23.4	.9	2.2	.2	6.9	.4
North shore	72.2	......	[2] 42.4	......	[2] 21.2	......	2.0	......	6.6	......
South shore	3.0	......	.3	......	2.2	......	.2	......	.3	......

[1] Negligible.

[2] Because the time periods for a total of 63.6 sq. mi. reclaimed between 1850 and 1925 in the north shore portion of Suisun Bay could not be definitely ascertained, these 63.6 sq. mi. were proportionally allocated between the periods 1850–1900 and 1900–1925.

Sources: U.S. Coast & Geodetic Survey Nautical Charts Nos. 5531, -32, -33, -34; land-use maps prepared by local planning agencies; and field observations, 1957.

Table 37 details the various uses of reclaimed land in the Bay Area in 1957. A summary of the programs of reclamation of marshlands and of tide and submerged lands in the San Francisco Bay Area from 1850 to 1957 is presented in table 38.

Following are résumés of reclamation as carried out between 1850 and 1957 in the three bays.

66. *San Francisco Bay Proper*

Nearly 95 square miles of land have been reclaimed from San Francisco Bay proper since 1850; of this reclaimed area, some 78 square miles were marshland, and some 16 square miles submerged lands. (See table 35.) The total amount of land reclaimed from San Francisco Bay proper has been greater than that reclaimed from each of the other two bays. Reclamation from San Pablo Bay and Suisun Bay was principally for agricultural and recreational purposes, and it was achieved largely by draining marshland. Reclamation in San Francisco Bay has involved the filling and draining of substantial amounts of land for such additional uses as transportation, industry, commerce, and military functions. In this chapter and for plate 20 (see plate supplement) special definitions are used for the land-use categories, because existing land-use maps for the area do not, in all instances, show use in specific terms. For the purposes of this chapter, transportation includes port facilities, such as docks, wharves, and warehousing facilities, major railroad rights-of-way, multiple-lane highways, and airports; lands in industrial use are those used predominantly for manufacturing, although there may be warehouses connected with port facilities on parts of this land; reclaimed lands used for military purposes are included in a separate category even though many of the installations are transportation-oriented (those installations include San Francisco Naval Shipyard at Hunters Point; Alameda Naval Air Station; Navy Supply Center, Oakland; Army Supply Depot, Oakland; Fort Mason, an oversea depot of the U.S. Army Transportation Corps; and Crissy

Air Field, a service field for the Presidio). Thus, much more than the 13.6 square miles shown in table 37 for the Northern Section of San Francisco Bay proper is transportation-oriented.

(*a*) *Northern Section.*—Over 36 square miles of land have been reclaimed in the Northern Section of San Francisco Bay since 1850. (See table 37.) Although this is less than in other parts of the Bay Area, this reclamation has been most important economically. Nearly all was accomplished by filling, and 45 percent (16.4 square miles) of the reclaimed lands were tide and submerged lands. In contrast, only 0.3 square mile of tide and submerged lands has been reclaimed elsewhere in the entire San Francisco Bay Area.

Reclamation in the Northern Section started in San Francisco, about 1850, in the area which is now lower Market Street. The progress of reclamation here exemplifies nearly all subsequent reclamation in the Northern Section of San Francisco Bay.

The village of San Francisco was located on the shore of Yerba Buena Cove, which extended from Clark's Point at the foot of Telegraph Hill southward to Rincon Hill as far as what is now Montgomery Street. West of the cove were dune lands. The cove was shallow, and ships had to anchor offshore, where they were served by lighters.

In 1848, San Francisco had a population of less than 1,000. The discovery of gold in California rapidly changed the small village to a crowded, busy, port city. Land was needed for housing and commercial facilities. To provide this land, the sand dunes along Market Street were leveled and the material dumped into Yerba Buena Cove. In addition, wharves were constructed so that ships could unload directly to shore. As these wharves were built and extended, commercial activities sprang up beside them and followed the wharves into the cove. Much of this part of the city was first built over the water and supported by piles, but filling of this area soon followed.[11]

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[11] In 1867, the State Board of Harbor Commissioners initiated work on a seawall located at what is now the Embarcadero. A trench 60 feet wide was dredged to 20 feet below low-tide level, and rock from Telegraph Hill and from Sheep Island was dumped to reach a level of mean low tide. A foundation of concrete was laid on top of the rock and a wall of masonry placed on the concrete. Filling of Yerba Buena Cove was rapidly accomplished following the construction of this seawall. The wall in its present form, however, was not completed until 1913.

Table 37.—Use of Reclaimed Tide, Marsh, and Submerged Lands in the San Francisco Bay Area: 1957

[In square miles]

Area	Total, all uses	Transportation	Industrial	Residential and commercial	Military and other reserved lands	Recreational	Salt ponds	Agricultural	Dumps and vacant lands
Bay Area, total	242.8	17.5	11.7	9.5	15.2	65.4	60.1	56.4	7.0
San Francisco Bay	94.8	16.0	10.3	8.7	5.0	1.4	44.5	4.4	4.5
Northern section	36.4	13.6	8.4	5.7	5.0	.8	...	1.0	1.8
Alameda County	15.1	6.9	.8	2.3	3.6	.6	...	...	.9
San Francisco and Upper San Mateo County	12.8	5.0	5.3	.6	1.2	.2	...	...	.5
Marin County	5.1	.6	.9	2.5	.2	...	...	.5	.4
Contra Costa County	3.3	1.1	1.4	.3	...	...	...	.5	...
Southern section	58.4	2.4	1.9	3.0	...	.6	44.5	3.4	2.7
West shore	34.3	1.9	1.9	3.0	...	.6	21.2	3.1	2.7
East shore	24.1	.5	...	...	...	...	23.3	.3	...
San Pablo Bay	72.8	.6	.6	.5	9.6	1.7	15.6	42.6	1.6
North and west shores	72.5	.6	.3	.5	9.6	1.7	15.6	42.6	1.6
Southeast shore	.3	(1)	.3	...	...	...	...	...	(1)
Suisun Bay	75.2	.9	.8	.3	.6	62.3	...	9.4	.9
North shore	72.2	.3	...	.3	(1)	62.3	...	9.4	...
South shore	3.0	.6	.8	...	.6	(1)	...	...	.9

[1] Negligible.

Note.—Totals do not add due to rounding.

Sources: U.S. Coast & Geodetic Survey Nautical Charts Nos. 5531, -32, -33, -34; land-use maps prepared by local planning agencies; and field observations, 1957.

The greatest amount of reclamation has occurred in the immediate vicinity of San Francisco and Oakland. In the part of Contra Costa County between Point Fleming and Pinole Point, reclamation has been relatively unimportant. The part of Marin County which belongs in the Northern Section of San Francisco Bay proper, however, has experienced a revival in reclamation since 1940 after approximately 40 years of only slight activity. (See table 36.)

Earliest reclamation occurred in the harbors of San Francisco and Oakland. This was followed by reclamation along the shorelines to the north and south, and in the peripheral areas, also outward into the Bay, particularly around San Rafael, Marin County, and north of Point San Mateo, San Mateo County. The later projects appear to have been connected primarily with agricultural activities.

The uses of reclaimed land in the Northern Section of San Francisco Bay proper are much more intensive than in other parts of the Bay Area. Whereas, for example, most of the reclaimed land in San Pablo Bay is used for agriculture and salt ponds, and in Suisun Bay for agriculture and recreation, here it is used principally for transportation, industry, residences, commerce, and military installations.

Reclaimed lands now in residential or commercial use are located in lower Market Street in San Francisco, adjacent to U.S. Highway 101 in Marin County, and in Alameda County. The largest project in Alameda is one recently undertaken on the south side of Alameda Island. Since the field investigations for this report were terminated, the filling has been completed, a shopping center has been developed, and residential construction has been undertaken.

Only 16.7 square miles of tide and submerged lands have been reclaimed from the three bays by filling. (See table 38.) As will be discussed later, the costs of reclaiming this type of land are, in general, much higher than costs of marshland reclamation. Plate 20 (see plate supplement) shows the location of this land, and comparison of plate 20 with plate 19 shows the pattern of growth along the waterfront from 1850 to 1957.

Prior to 1900, nearly all this type of reclamation occurred on the San Francisco waterfront between Fisherman's Wharf and Islais Creek. Small amounts of tide and submerged lands also were reclaimed in the inner harbor of Oakland and at Sausalito. Between 1900 and 1925, the major operations were in the Oakland outer harbor area, but some supplemental reclamation occurred on the San Francisco waterfront. In the period 1925–40, most of the reclamation of tide and submerged lands continued to center in the Oakland outer harbor area. There were additions to the San Francisco waterfront, and some filling occurred at the San Francisco Airport. During this same period, reclamation of tide and submerged lands took place also in Richmond Harbor and on Treasure Island. Since 1940, major reclamation work has occurred at Hunters Point, between Candlestick Point and Sierra Point, at the San Francisco International Airport, at the Oakland Airport on Bay Farm Island, and on the south side of Alameda. There has been further work, mostly related to highway construction, in the Richmond Harbor area, between Emeryville and Berkeley, and in scattered places in Marin County.

Table 38.—Marshlands and Tide and Submerged Lands Reclaimed From the 3 Bays, San Francisco Bay Area: 1850–1957

[In square miles]

Period	Marshlands	Tide and submerged lands
1850 to 1900	72.6	1.5
1900 to 1925	60.9	2.5
1925 to 1940	38.7	4.7
1940 to 1957	53.9	8.0
Total, 1850 to 1957	226.1	16.7

(*b*) *Southern Section.*—Originally there were about 75 square miles of marshlands in the Southern Section of San Francisco Bay proper, of which over 58 square miles, or nearly 80 percent, have been reclaimed. The remaining marsh occurs in widely distributed plots, with a total of less than 8 square miles on the west shore and less than 8 square miles on the east shore.

Reclamation began slowly in the Southern Section and has been limited entirely to marshlands. Less than 9 square miles were reclaimed between 1850 and 1900. The salt industry on the east shore, located principally in the area west of Alvarado, reclaimed about half of this amount. Most of the remaining marshland was reclaimed for agricultural use, though small amounts of land were reclaimed at Redwood City and Alviso for port facilities.

During the period 1900–1925 there was very little reclamation. The only activity, amounting to a total of less than one-half square mile, was in scattered locations near the port of Redwood City.

Most of the reclamation in the Southern Section occurred between 1925 and 1940; 29.7 square miles of land were reclaimed during these years, mostly for salt ponds. This rate dropped in the period 1940–57. By the end of 1957, however, less than 17 square miles of unreclaimed marshlands remained, and much of this land was in areas adjacent to creeks and sloughs.

On the east and west shores combined of the Southern Section, salt ponds account for 76 percent of all the reclaimed land. (See table 37.) The next largest use is for agriculture, in amount presently totaling only 3.4 square miles. More land was reclaimed originally for this purpose, but other uses, such as housing, industry, and transportation, have encroached upon it in recent years. Examples include the residential and industrial development along the Bayshore Freeway and in the Burlingame-San Mateo area. Such land, originally marshland and land reclaimed by levees and drainage for agricultural and salt-pond use, was filled for the aforementioned purposes. Much of the land below the 5-foot contour, now on sale for industrial and residential purposes, is land that was reclaimed for less intensive uses by draining during earlier periods but has been filled since.

67. San Pablo Bay

San Pablo Bay, which lies north of San Francisco Bay proper, once had extensive marsh areas on its west and north shores. These marshes extended up Petaluma Creek as far as the city of Petaluma. A small marsh area existed also on the southern shore to the east of Point San Pablo. Because the development of this marshland contributed to the growth of the East Bay area, it was included in the Northern Section of San Francisco Bay proper.

Reclamation in San Pablo Bay has been accomplished primarily by draining of the marshlands. In 1850, approximately 94 square miles of marshlands existed along the north and east shores of San Pablo Bay. Seventy-three square miles of this area have since been reclaimed. (See table 36.) The remaining 21 square miles of marshland are widely distributed throughout the area. Reclamation started shortly after the passage of the Swamp and Overflow Act in 1850, and reclamation districts were formed as early as 1861. In recent years, reclamation has been carried out by private individuals.

The use of land reclaimed in San Pablo Bay tends to be related to the date of reclamation. A comparison of plates 19 and 20 (see plate supplement) shows that nearly all of the land reclaimed before 1925 is in agricultural use and that much of the land reclaimed since 1940 is in salt ponds or military use. These last two uses also have encroached upon lands which were originally reclaimed for agriculture.

The only lands reclaimed by filling are those used for residential, commercial, transportation, and industrial purposes, and some of the lands in military use. The amount of filled land is negligible—less than 3 square miles in over 100 years.

A small amount of reclamation by filling has occurred on the southeast shore of San Pablo Bay, between Pinole Point and Crockett, for industries which built plants along the shoreline to take advantage of shipping by water and the paralleling railroad line. Two hundred acres of such land were reclaimed between 1900 and 1940.

68. Suisun Bay

Suisun Bay lies between a line from Simmons Point to Stake Point, Sacramento River, on the east and Carquinez Strait on the west. For purposes of this study, it includes Benicia and the marshlands on the northern shore of the strait and the area from Pittsburg to Martinez on the south shore.

(*a*) *North shore.*—The north shore of the bay is a broad, shallow basin, which once consisted of over 96 square miles of marshlands, interspersed with numerous tidal sloughs and islands. Reclamation in this area began in the early 1860's, following the passage of the early reclamation acts. According to the Water Resources Board of the State of California, more than 20 reclamation districts were formed between the years 1860 and 1880 to reclaim most of this marshland.

The levees that were constructed were only high enough to protect the land against normal high tides, and it remained subject to flooding from abnormally high tides or high stream levels. Subsidence of both the dried marshlands and the levees further reduced the effectiveness of the levees. As a result, most of the reclamation districts had become inactive by 1930. At that date, only four were reported active, representing a gross area of slightly over 6,000 acres (about 10 square miles). Between 1914 and 1943, much of the reclaimed land was lost by flooding, and most of this area now serves as a home for wild waterfowl. Many private duck-hunting clubs own or lease lands in these marshes, and the California Fish and Game Commission operates the Joice Island Game Refuge, comprising nearly 1,900 acres, and the Grizzly Island Waterfowl Management Area, 8,600 acres in size.

In the Grizzly Island Waterfowl Management Area, the State has been rebuilding the levees to provide better control of water on these lands. The major levees bordering Montezuma Slough, Roaring River Slough, and Suisun Bay are being rebuilt to protect against 12-foot combined tide and flood levels.[12] Water is controlled to maximize the growth of duck feeds and thus provide feeding grounds for the wintering ducks.

Thus, the major use of reclaimed land in the north shore area is for recreation, with only a little over 9 square miles in agricultural use. The balance, some 0.6 square mile, is used for residential, commercial, and transportation purposes. A very small amount of land in Benicia is vacant, and another small area east of Benicia is in military use. (See table 37.)

(*b*) *South shore.*—Along the south shore of Suisun Bay, a narrow strip of marshland, about 14.5 square miles in area, extends from Pittsburg to Martinez. Only 3 square miles of this land have been reclaimed, with most of the reclamation accomplished by filling rather than draining. Most of this reclamation took place between 1900 and 1925. (See table 36.)

The activity during this period was probably the result of main-line construction by the Atchison, Topeka & Santa Fe Railroad and the Southern Pacific Railroad, and building of the paralleling highway. At the present time, about one-third of the reclaimed land is vacant. Industry and transportation use about 1.5 square miles, while the balance is used for military or recreational purposes.

ECONOMICS OF RECLAMATION

69. Scope

The history, location, and methods of reclamation of marsh, tide, and submerged lands in the San Francisco Bay Area have been examined and the uses of the reclaimed lands described. Rate of reclamation, nature of reclamation method, and location of reclamation projects depend upon a number of factors. Outstanding among these are, first, increases in population density to the point where existing lands suitable for various uses are becoming scarce, and, second, the costs of reclaiming additional land for these uses.

It is difficult to measure economic costs of reclamation against future scarcity values of ordinary lands suitable for a considerable number of widely divergent purposes. Also, differences in methods of reclamation, in necessary depth of fill, and in pertinent transportation distances, to mention only a few variables, do not permit drawing precise conclusions in regard to reclamation costs, present and future.

It is believed, however, that a discussion of actual and proposed projects within the Bay Area may aid in delimiting cost ranges that can be anticipated there.

70. Costs of Levee and Drainage Reclamation of Marshland

Generally, it costs far less to reclaim land by drainage than by filling. The major expense involved in a drainage project in the Bay Area is the cost of levee construction and maintenance. Most projects in the Bay Area which involve the draining of marshlands have been undertaken by private interests, and little cost information on these projects is available. However, the work of the California Fish and Game Commission in rebuilding the major levees enclosing the Grizzly Island Waterfowl Management Area yields some pertinent cost information, particularly with reference to levee construction.

In 1952, a 2-mile-long cored levee was constructed for this project at $9,000 a mile. This levee had a 4- by 5-foot core, was 6 to 8 feet wide at the top, and had slopes of 2:1. In 1957, 5 miles of the Roaring River Slough levee were rebuilt for $3,000 a mile. This levee was designed to protect the enclosed area against 12-foot tides (mean lower low water). Specifications for this levee were that it be 10 feet high with a 15-foot top and 2:1 slopes. In 1958, interior levees were constructed at a cost of $5,000 a mile. These levees were only 5 feet high, had 12-foot tops, and 2:1 slopes. Using the Engineering News-Record construction cost index for changes in cost, the cored levee built in 1952 for $9,000 a mile would cost over $12,000 today. Maintenance costs of the major levees enclosing the Grizzly Island Waterfowl Management Area are estimated at $750 a mile for fiscal year

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[12] Based on mean lower low water datum, which is 2.1 feet below mean sea level in this area.

1959, and annual ditch maintenance, cleaning, and burning are estimated at $175 a mile.[13]

71. Costs of Reclamation by Fill

Costs of filling land range widely, primarily because of variations in the cost of constructing retaining walls, depth of fill, and differences in cost of fill material. The cost of material for filling depends largely upon whether the material is hydraulic or dry, and also upon the pumping distance or length of haul required.

Data pertinent to construction costs were collected by an Office of Area Development survey questionnaire on 10 fill projects which have been completed in the Bay Area since 1938. Four of these projects were privately constructed and six were constructed by government organizations. Three projects were designed for military use, two for airports, two for industrial purposes, two for residential or commercial uses, and one for a highway. Some of the projects involved the filling of only marshlands, some the filling of only tide and submerged lands, while others involved a combination of both. Following are summarized results of the survey of these projects.

The 10 projects represent the filling of 6,000 acres of land (about 9.5 square miles) at an average cost of $8,300 per acre.

The highest cost, over $50,000 per acre, was for a fill for the Bayshore Freeway from Candlestick Point to Sierra Point. However, this fill is actually a big dike as compared with comparatively shallow fill over extensive areas required for the other nine projects. The Candlestick Point fill is about 11,000 feet long, about 400 feet wide at the top for a short distance from the north end, and 250 feet wide at the top for the remaining length. It was constructed by end-dumping dry fill material over mud with upper surface from 3 feet to 5 feet below mean lower low water, and from about 20 to nearly 80 feet thick. The cost per cubic yard of material placed in the fill is more significant in this case than the cost per acre. The cost of the fill was about 84 cents per cubic yard for about 4,500,000 cubic yards.

The lowest cost was $4,100 per acre for fill placed by dredge on marshlands. These two projects represent extremes. The average cost per acre, however, still remains about $8,000 when these two projects are omitted from the calculation of the average.

This average cost of roughly $8,000 per acre is definitely on the low side, because a number of the projects date back to the late 1930's and the 1940's. For example, the average cost of filling Treasure Island was $9,500 per acre in 1936. The cost of filling Treasure Island today probably would be about $30,000 per acre, using the Engineering News-Record construction cost index as a guide. Similarly, the cost of the filling for the Naval Supply Center at Oakland in 1940–42 averaged $5,150 per acre. At current price levels, the average cost for this project would probably be about $14,000. It should be noted that these costs include only the filling of the land and do not include the costs of installing utilities, streets, curbings, or other facilities.

As stated above, the cost of reclamation, particularly filling, varies widely depending on engineering methods, depth of fill, and the distance over which fill material must be transported. In some of the 10 projects studied, the fill was placed by dredges; in others, it was quarried and trucked to the site.

Depth of fill also varied considerably, ranging from an average of 4 feet for one private project to an average of 30 feet for the Bayshore Freeway at Candlestick Point.

Details of the six projects sponsored by public agencies are provided in table 39. Detailed cost information on the four projects undertaken by private interests was not included in order to avoid disclosure. In general, however, the costs per acre of private reclamation projects did not differ materially from costs of public projects.

Availability of suitable fill material constitutes another major cost variable. In the construction of Treasure Island, some sand for dredging was available at the site, but over 7 million cubic yards of sand were transported by hopper dredges from other parts of San Francisco Bay. Most of this sand had to be stockpiled and rehandled by floating equipment. For other projects, notably those near Oakland and Alameda, sand was available adjacent to the site of the fill project. In some of the

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[13] These costs were furnished by the Fish and Wildlife Service of the U.S. Department of the Interior. They are estimates made by the State of California in connection with the use of Putnam-Robertson Act funds (Federal Aid and Wildlife Restoration Act, 50 Stat. 917, September 1937). Because these estimates were not revised upward, as required if actual cost is higher, it can be assumed that they are maximum. All costs are for fiscal years.

Table 39.—Cost of Reclamation, by Filling, of Recent Public Projects in the San Francisco Bay Area

Location and project	Sponsor	Use	Type of land filled	Date	Area	Cost			
						Dikes	Fill	Total	Cost per acre
					Acres	*Thousands*	*Thousands*	*Thousands*	
Alameda County:									
Naval Air Station, Alameda	U.S. Navy	Military airfield	Marsh, tide, and submerged.	1938 to 1957	993	$2, 268	$7, 346	$9, 614	$9, 700
Naval Supply Center, Oakland.	do	Military depot	do	1940 to 1942	[1] 250	48	1, 239	1, 287	5, 150
Metropolitan Oakland International Airport.	Port of Oakland	Commercial airport.	Tide and submerged	1957 to 1958	[2] 1, 400	1, 200	5, 000	6, 200	(2)
San Francisco County:									
Treasure Island	City of San Francisco and Works Progress Administration.	Military	Submerged	1936 to 1937	401	(3)	(3)	3, 804	9, 500
San Mateo County:									
Candlestick Cove-Sierra Point Highway.	California Division of Highways.	Freeway	Tide and submerged	1952 to 1956	68	0	3, 770	3, 770	55, 500
San Francisco International Airport.	City and County of San Francisco.	Commercial airport.	Marsh, tide, and submerged.	To 1953	[4] 2, 182	0	13, 890	13, 890	6, 400

Source: Office of Area Development survey questionnaires sent to sponsoring agencies, 1958.

[1] Fill made between existing moles.

[2] Total area enclosed by levee is 1,400 acres, of which 600 acres have been filled, with the balance scheduled to be drained. The cost of the dike was $1,200,000 or $860 per acre of enclosed area. The cost of filling 600 acres was $5,000,000, or $8,300 per acre.

[3] Not available.

[4] Includes the entire expansion program.

private projects, use was made of dry material from small hills within or immediately adjacent to the site of the fill. By removing the material from the hill, both the reclaimed area and the hill area were made usable for development. This method significantly reduced project costs.

72. *Cost Comparison of the Two Methods for Reclaiming Tide and Submerged Lands*

In a study of cost estimates for reclaiming three areas of tide and submerged land—one in each bay—believed to have the greatest potential value, the California Division of Water Resources (226, app. D, pp. D74–78) obtained results which illustrate the very significant cost differences between levee-and-drainage and fill-type reclamation. The three areas selected for this study were:

(*a*) In San Francisco Bay, 23,360 acres lying between San Lorenzo Creek and Coyote Hill Slough along the eastern shore of the southern part of the bay;

(*b*) In San Pablo Bay, 27,660 acres lying between Tolay Creek and Mare Island on the northern shore of the bay;

(*c*) In Suisun Bay, 7,530 acres in Grizzly Bay and Honker Bay.

The two methods of reclamation, levee and drainage, and filling, were considered. Reclamation by levee and drainage was considered suitable for agricultural use and salt production but not for residential and industrial development. Filling of areas for the latter purposes was to be accomplished by the construction of a levee to a height 10 feet above mean sea level, while the surface of the fill within the enclosed area was to stabilize at an elevation equal to mean high water. The design of the levee was essentially the same for both methods.

Using specified unit costs (226, app. D, pp. D74–78), the California State Division of Water Resources arrived at the following estimated costs of reclaiming these three parcels of land. (See table 40.)

Table 40.—Estimated Capital Costs of Reclamation of Tide and Submerged Land by Levee and Drainage, and by Filling, San Francisco Bay Area: 1955

Area	Cost per acre by levee and drainage	Cost per acre by filling
San Francisco Bay	$1, 000	$27, 200
San Pablo Bay	810	27, 000
Suisun Bay	960	22, 100

On the basis of a 50-year amortization of capital costs at 3 percent interest, and including operating and maintenance costs, the annual cost of reclamation by levee and drainage would be between $33 and $41 per acre, and that of reclamation by fill would be between $860 and $1,060 per acre.

This California State Division of Water Resources study assumes cost of sand for levees at 75 cents per cubic yard and cost of material for fill at 93 cents per cubic yard, but it does not explain the basis for these figures. A 1956 report to the city of Berkeley by an engineering firm (251, p. 46) states: "Sand deposits outside the city limits remaining in the Bay Area are in short supply and would be costly to use for fills. The cost would range from $1.50 to $2.00 per cubic yard in place in the fills."

Because the Berkeley project is much closer to the sources of available sand than are the three projects studied by the California State Division of Water Resources, the expense of transportation would make the cost of sand even higher. In fact, the comparatively small amount of sand available locally throughout the Bay Area for levee building and for fill, compared with the large amount and considerable thickness of the Bay muds, is one of the most serious handicaps of reclamation by fill.

73. Factors Stimulating Reclamation in the Bay Area at Present

Most areas reclaimed from tide and submerged lands have been used for civilian or military ports and airports. Much of the filling for port development has resulted from two factors: the need to reach deep water so that ships' cargoes may be loaded directly to or from shore; and the need for level land for the necessary storage and handling of goods. In San Francisco, deep water lies close to shore. Yerba Buena Cove was filled because of the need for deepwater docking facilities.

Filling in the port of Oakland was necessary for a similar reason. Shallow water extended a considerable distance outward from the Oakland shore, and long piers had limited storage and freight-handling facilities, were expensive to maintain, and were not economical in terms of the time needed to move cargoes on and off the piers. Furthermore, the number of ships which could use the facilities was limited by the number of piers. The area between shore and deep water was filled to provide more efficient docking facilities.

The second largest use of reclaimed tide and submerged lands in the Bay Area has been for airports. An airport serving a metropolitan area should be as close in time as possible to the commercial core of that area. On the other hand, airports require extensive areas of level land and open approaches. Comparatively little level land exists in the San Francisco-Oakland area, and such land physically suitable for airports was long ago put to other uses. The early airports were built on filled marshland. As air traffic increased and planes increased in size, larger airports were required, and some tide and submerged lands were reclaimed to obtain sufficient land to meet those needs.

Some reclamation of tide and submerged lands has been brought about by other factors, such as the need for expansion of industrial facilities. In one instance, an industrial plant was constructed on shore and, in the course of time, other establishments grew up adjacent to it. When expansion became necessary, it proved cheaper to reclaim land than to buy some of the neighboring properties or to move the entire plant to some other location. This apparently is also the reason for some of the filling done by the Navy Department at Hunters Point. Another example is the filling for the Bayshore Freeway from Candlestick Point to Sierra Point. Although this was an expensive fill project, it was cheaper than selecting alternate routes which would have required the purchase of highly valuable residential, commercial, and industrial lands for the right-of-way.

The presence or absence of fill material also has been a determining factor in reclamation. Some of the private projects for residential and commercial uses which appear to be anomalies in the whole pattern of reclamation have been accomplished because material for filling was close at hand. For instance, there is a fill area to be used for residential purposes at California Point on the Tiburon Peninsula in Marin County. The fill material for this project came from a hill nearby. In using this source of fill, the company gained not only the reclaimed land but also the site of the former hill for the construction of houses. Similarly, the fill for the South San Francisco Industrial Park is being obtained from a high area which, once it has been leveled, will then become available for development. The filling of tide and submerged lands for residential and commercial development on the south side of Alameda Island is due partly to the availability of sand in the Bay close to the site of the project.

According to an estimate made by Region IX, Public Health Service, San Francisco, of the U.S. Department of Health, Education, and Welfare, there will be a need for 37.5 square miles of land and/or water for the disposal of so-called solid waste [14] in the Bay Area between the years 1965 and 2015, if it is assumed that such disposal will continue to be accomplished largely by the sanitary land-fill method. This method is a slight refinement of the traditional open-dump operation. Nonsegregated solid wastes are deposited as a fill, compacted in order to reduce volume, and covered at the end of each operational day so as to prevent nuisances or hazards to public health. The operation is still inexpensive, though it is an improvement over the open-dump method. Tide and unleveed marshlands are considered to be the most logical and economical areas for the location of such fills.

Thus, a form of land reclamation results from this process. However, lands so reclaimed have a number of disadvantages, among which probably the most important is uneven, long-continued, and frequently unpredictable settlement. Such areas cannot bear heavy loads, and necessary excavations may pose unpleasant and difficult problems. Nevertheless, sanitary land fill, if executed correctly, may yield some lands for park and other recreation purposes and perhaps even for certain types of light industries. In other words, a certain amount of this form of reclamation probably can be worked into some shore-development plans which require reclamation of marsh or tide lands.

The sanitary land-fill method of disposal of solid waste has, however, a number of other decided disadvantages which are likely to become more troublesome as population increases. Thus, as has happened in other densely populated areas in different parts of the world, a trend toward better, though more expensive, methods of disposal may develop. In that case, the total amount of land eventually reclaimed in the Bay Area by the somewhat questionable method of sanitary land fill will remain well below the 37.5 square miles mentioned above.

THE FUTURE OF LAND RECLAMATION IN THE BAY AREA

74. Reclaimed vs. Unreclaimed Land

Most of the land reclaimed thus far in the San Francisco Bay Area has been marshland—about 225 square miles out of an available total of somewhat over 300 square miles. (See table 35.) In comparison with this, the amount of tide and submerged lands reclaimed to date is small—slightly less than 17 square miles. However, the amount of tide and submerged lands still physically susceptible of reclamation is large (see pl. 21, plate supplement)—approximately 250 square miles, as against 80 square miles of marshlands.

75. Future Demand for Land

What will be the future trends in reclamation? Flatland in the neighborhood of large urban agglomerations is generally in demand for a variety of purposes. In a region such as the Bay Area, where level land is far from abundant, it may be expected that a projected population increase, from nearly 4 million now to over 14 million in 2020, would be accompanied by an increase in demand for level land. If this demand were not satisfied by natural land, then artificial land, such as that obtained by leveling minor irregularities or by reclamation, would fill increased level-land needs.

76. Rates of Reclamation

(*a*) *Marshlands.*—Thus far, the percentage rate of increase in the total amount of reclaimed land (tide, submerged, and marshlands) in the Bay Area has not changed materially since 1925. The same is true for the amount reclaimed from marshlands only. This is illustrated by the semilogarithmic graph, figure 12, which is based on tables 36 and 38. If, for the marshlands, the average trend from 1940 to 1957 is projected into the future (see fig. 12), all available marshlands—somewhat over 300 square miles—would be reclaimed by about 1975. However, while no study has been made here of the relative advantages of reclaimed marshlands over marshlands that have not yet been reclaimed, it may be generalized that the more easily and more cheaply reclaimable marshlands were developed before others, where costs would be higher. Thus, even with increasing population, the 1940–57 reclamation rate might not be maintained due to increasing costs. Nevertheless—even taking into account a slowing down of the rate of marshland reclamation—it appears likely that, by about 1990, little unreclaimed marshland will remain in the Bay Area. In almost all instances it probably can be assumed that reclamation of these remaining marshlands will be beneficial and will not disturb existing or proposed balances within the Bay Area.

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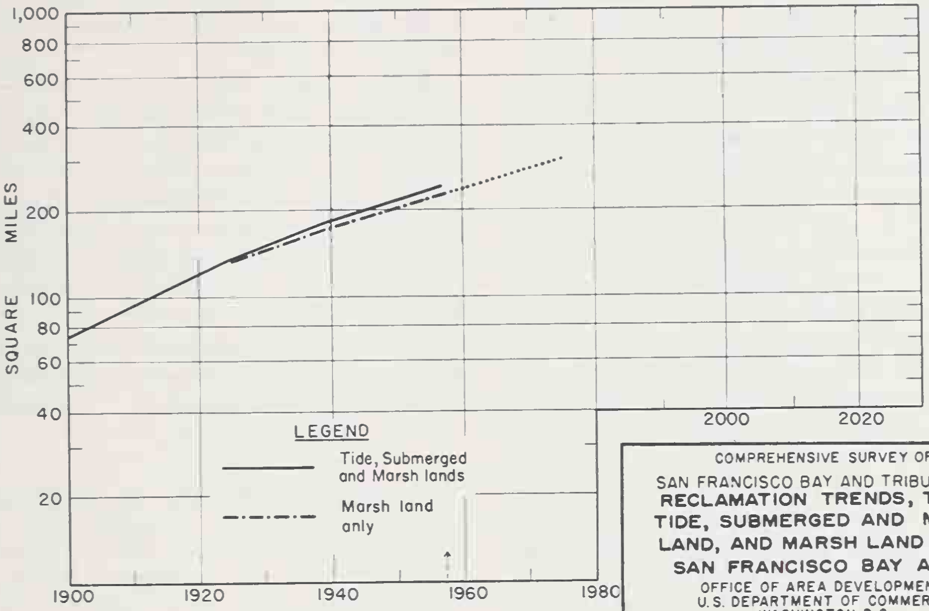
[14] Solid waste comprises all putrescible and nonputrescible solid wastes (except body wastes), including garbage, rubbish (combustible and noncombustible), ashes, street cleanings, dead animals, abandoned automobiles, and solid market and industrial wastes, plus dried or semiliquid wastes originating from municipal or industrial sewage or waste-treatment plants.

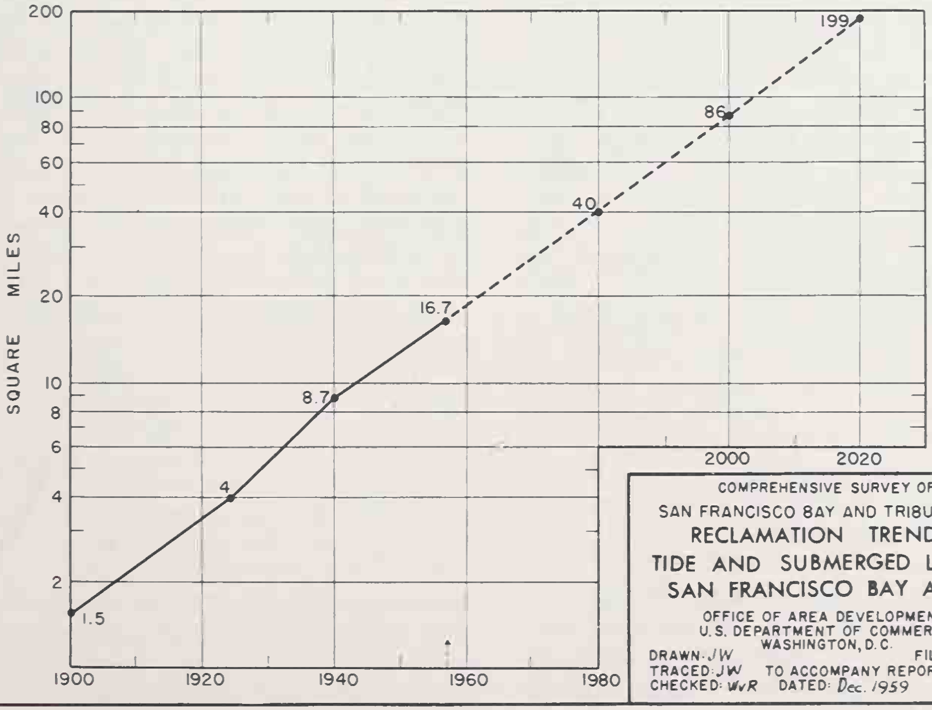
CORPS OF ENGINEERS U. S. ARMY

FIGURE 12



COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES
RECLAMATION TRENDS, TOTAL TIDE, SUBMERGED AND MARSH LAND, AND MARSH LAND ONLY
SAN FRANCISCO BAY AREA
OFFICE OF AREA DEVELOPMENT
U.S. DEPARTMENT OF COMMERCE
WASHINGTON, D.C.
DRAWN: J.W. FILE NO.
TRACED: J.W. TO ACCOMPANY REPORT
CHECKED: WvR DATED: Dec. 1959

FIGURE 13



COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES
RECLAMATION TRENDS, TIDE AND SUBMERGED LANDS
SAN FRANCISCO BAY AREA
OFFICE OF AREA DEVELOPMENT
U.S. DEPARTMENT OF COMMERCE
WASHINGTON, D.C.
DRAWN: JW FILE NO.
TRACED: JW TO ACCOMPANY REPORT
CHECKED: WvR DATED: Dec. 1959

Plate 21 shows the geographic distribution of the marshlands that are not yet reclaimed. Most of the unreclaimed marshlands are located in the Suisun Bay region, while smaller areas lie along sloughs, streams, and the bay shores in the San Pablo region, and others occur scattered around the Southern Section of San Francisco Bay proper. The concentration of so much of the unreclaimed marshlands around Suisun Bay, away from the major centers of population, may be an additional factor in slowing down the rate of reclamation of this type of land.

(*b*) *Tide and submerged lands.*—Tide and submerged lands are in a different category from marshlands: they are from somewhat lower to considerably lower in elevation; building of levees, and maintenance of levees (particularly of main, outer levees) are both apt to cost more; recurrent costs of drainage are apt to be higher; and, if fill is applied, the total quantities necessary may greatly exceed those needed for marshlands. Thus it is logical that until now, with the exception of certain strategically located areas for commercial, industrial, and transportation purposes, comparatively little tide and submerged land has been reclaimed. It probably also is logical to assume that most of the marshlands will be reclaimed long before all tide and submerged lands physically susceptible of reclamation have been reclaimed. In fact, it is highly doubtful that the "physically susceptible" areas ever will be reclaimed in entirety, or even that complete reclamation of these lands would be beneficial to the Bay Area.

Tide and submerged lands available for reclamation, as presented in plate 21, are approximately the same as those defined by the California State Division of Water Resources as "lands susceptible of reclamation" (226, app. D). In general, such lands were considered to extend about to the edges of the deeper channels, which edges lie mostly at depths of less than 12 feet below mean lower low water. However, if levees should be constructed along the outer edges of these lands, the levee bases would lie, on the average, not more than 6 or 7 feet below mean lower low water. This is no great depth in comparison with, for example, that of levee bases of the Zuider Zee reclamation project in the Netherlands.

The amounts of tide and submerged lands reclaimed between 1900 and 1957 fall into a curve that ascends much more steeply than the similar curve for the marshlands (figs. 13 and 12, and table 38). If the 1940–57 trend were projected, totals of such land reclaimed in 1980 would be about 40 square miles; in 2000, about 86 square miles; and in 2020, about 199 square miles. The latter figure would still be well short of the total available of about 250 square miles.

However, even if population in the Bay Area were to increase from 4 to over 14 million, it would be unsound to assume that the 1940–57 trend will continue. Costs of reclamation, by levee and drainage, and especially by fill, are apt to increase at a very much higher rate for the less advantageous tide and submerged lands than even for the least favorable marshlands. All things considered, it seems highly unlikely that during the next 60 years the earlier rate can be maintained. To what extent the real curve will remain below the projected curve is difficult to foretell at this juncture, as a considerable number of factors are involved.

77. *Unfavorable Factors Affecting Reclamation of Tide and Submerged Lands*

Among the factors affecting reclamation of tide and submerged lands, unfavorable physical factors loom large. Although the number of reliable test borings in the shallower parts of the three bays—San Francisco, San Pablo, and Suisun—is small, particularly in the deeper parts, and poorly distributed geographically as well, all available facts seem to point to a preponderance of soft, and thick to very thick, bottom deposits of mud. This is in contradistinction to the Zuider Zee experience in the Netherlands, where comparatively thin bottom deposits of clays, clayey sands ("zavels"), and Holocene sands are underlain by very thick and comparatively solid Pleistocene and Pliocene sands. Inside the Golden Gate, it appears that sand for levee foundations and fill is rather scarce and located primarily at the upper end of Suisun Bay, in San Pablo Bay, in the Northern Section of San Francisco Bay proper adjacent to the eastern shore, in the deeper water of the Bay east of the Golden Gate, and off Alameda. Outside the Golden Gate, on the Bar, are available great quantities of sand, a portion of which possibly could be obtained at economic cost. As pointed out in the section on "Economics of Reclamation," cost of sand is high, and, if sand is as scarce as presently indicated, its cost is apt to rise disproportionately in future decades. It is evident also that reclaimed lands underlain by very soft, very thick muds will show a considerable amount of settlement, not only in the first years after reclamation, but at a diminishing rate for many years thereafter, the rate depending partly upon the eventual depth of the ground-water table. This situation will increase the total rate of cost of reclamation of the shallower areas, but, even more so, of the deeper areas.

Thus, from various points of view, it appears likely that only a portion of the tide and submerged lands susceptible of reclamation ever will be reclaimed. What portion eventually is reclaimed probably will depend largely upon future comprehensive and multipurpose plans for shoreline development.

As has been noted, the reclamation of tide and submerged lands in the Bay Area until now has been for transportation or such transportation-oriented facilities as ports or airports (whether undertaken by public authorities, the military, or private industry) and for freeways. Since these have been the major reasons for reclaiming the tide and submerged lands in the Bay Area, it is necessary to examine future needs for these facilities as well as future needs for other purposes, as discussed in the following paragraphs.

78. *Reclamation for Port Development*

Flatland adjacent to deep water is essential for the development of ports capable of handling ocean-going vessels. Will such lands be needed in the Bay Area, and, if so, where?

It is unlikely that great new ports will develop in the Bay Area within the period covered by this report. For a number of reasons there has been a trend in the United States and elsewhere in the world toward centralization of port activities. At one time, numerous ports existed on both the east and west coasts of this country. Improved internal transportation by both railroad and truck, the construction of larger and more specialized ships, and the need for more expensive dockside facilities for loading and unloading, have brought a concentration of traffic within a few ports and a diminishing of activity in most smaller ports on both coasts. However, even if there should not be an increase in waterborne trade in the Bay Area corresponding to the anticipated increase in population, there almost certainly will be a significant increase in domestic waterborne traffic, which will require expansion of port facilities.

In the San Francisco and Oakland areas, where there are port facilities on deep water, perhaps the need for more land can to some extent be offset by redesigning present docking facilities, installing specialized and more efficient material-handling equipment, and improving other techniques for storing and handling shoreside cargoes. Additions to present port facilities are possible in, for example, the Islais Creek-India Basin area of San Francisco. In addition, the Navy Department is considering filling areas on the south side of Hunters Point, and the port of Oakland Authority is considering the development of the Oakland North Harbor area located just north of the Bay Bridge. Considerable areas are available for port expansion in this latter neighborhood, provided suitable access can be created to the deep channel east of Treasure Island. There also are plans for the further development of Richmond Harbor, and there may be some port development associated with industrial expansion in the area between Pittsburg and Martinez, and in the southern part of San Francisco Bay. There are still other areas in the three bays sufficiently close to deep water where new port facilities can be created by means of reclamation of tide and submerged lands, but, on the whole, the total amount of such land needed for port expansion in the Bay Area is small in comparison with the 250 square miles available.

79. *Reclamation for Future Airport Needs*

As population in the area increases, so will the need for flatland for expansion of existing airports and the creation of new ones. The two major airports are Metropolitan Oakland International Airport and San Francisco International Airport. The Oakland Port Authority has recently completed filling about 1,600 acres of land to extend the present Oakland Airport, and San Francisco is adding an area on the southeast side of its airport to accommodate jet aircraft by reclamation of tide and submerged lands. Further reclamation possibilities exist in both areas. Although there are a number of small airports scattered throughout the Bay Area, it is quite possible that, as population increases, major airports may be needed in the south, and perhaps also in the north. It also is possible that, for purposes of accessibility from the air—especially for jet aircraft—and accessibility from the ground, new locations will be sought near the shore of the three bays, or even offshore. However, sufficient marshland and tideland (if desirable) probably would be available, and it might not be necessary to reclaim any large areas of submerged land—certainly, not any of the deeper areas. Thus, the need for additional land for airports is not a factor that will cause any large-scale reclamation of tide and submerged lands in the Bay Area.

80. Reclamation for Agricultural Uses

The high cost of reclamation would seem to preclude the use of reclaimed tide and submerged lands exclusively for agricultural purposes, even by the year 2020. Modern refrigerated trucks, the freezing of foods, and new techniques for preserving foods will probably make it unnecessary to grow an important proportion of the requirements for high-value crops, such as truck and fruit crops, close to the urban centers of the Bay Area. In the course of time, however, much agricultural land in the area will be taken over for residential and related purposes by the growing urban population. It is true that some of this land is in comparatively nonintensive agricultural use, but areas now in fruit and other orchard crops, for example, also will be affected. Moreover, as population increases, land for agricultural purposes will be used for more intensive forms of agriculture. If a need should develop for increased production of truck crops and similar high-value crops in the Bay Area, appropriate lands probably could be found in the marshland areas of San Pablo Bay, and especially of Suisun Bay.

81. Reclamation for Industrial Uses

The extent to which land will be reclaimed for industrial uses hinges largely on the cost factor. As noted earlier in this chapter, the cost of filling tide and submerged lands may go as high as $22,000 to $27,000 an acre in terms of 1955 prices. (See table 40.) It was observed also that these costs are probably conservative, with a figure of $30,000 per acre being more realistic.

To the basic cost of reclaiming tide and submerged lands must be added the subsequent cost of improving these lands for industrial use. The added average cost per acre for improving reclaimed land is difficult to estimate, since so many variables enter the picture. Several available studies and surveys, however, do give an insight as to cost ranges that can be anticipated.

In a recent survey of planned industrial parks by the Stanford Research Institute (212, p. 13), it was found that development costs in 24 industrial parks averaged 14.5 cents per square foot, or $6,316.20 per acre of salable land. In two parks, development costs exceeded $17,000 per acre.

Another useful set of cost estimates on the improvement of industrial land in the United States is presented in a study of planned industrial parks prepared by the U.S. Department of Commerce (205, p. 26). These estimates were used by the industrial department of a Midwest railroad in order to obtain an appropriation of funds to carry out an industrial park project of 120.9 acres. In this project, the per-acre development cost (in 1952 prices) was $8,360. Cost items included clearing, grading, drainage, trackage, roads, gas service and distribution, water service and distribution, sewer service and distribution, engineering fees, and sales and legal fees.

The foregoing estimates indicate that the present cost of developing land for industrial purposes in this country is in the neighborhood of $10,000 per acre. Where grading is not required, the cost probably will be several thousand dollars an acre less. By adding this $10,000 per acre for improvement to the estimated $30,000 per acre required for filling in the Bay Area, the total cost of improvement of reclaimed tide and submerged lands amounts to $40,000 per acre in terms of current prices.

Developed land having values of $25,000 an acre and over is used chiefly by industries and services which must locate near the center of an urban market area. These activities include business and repair services, distribution facilities, small units of printing and publishing concerns, and shops for the manufacture of specialty chemicals, high-fashion apparel, and certain other high-value, low-bulk manufactured items. These industries usually do not require extensive acreages, and they are normally prepared to pay higher prices for land.

In the San Francisco Bay Area, however, most of the remaining land which might be reclaimed by filling is not near the center of the urban market area, and therefore it would not be in demand by the kinds of industries that would be likely to pay $25,000 and up per acre. At a price of $40,000 per acre, there would be little if any demand for this land insofar as "pioneer" industrial development is concerned. It may be assumed, then, that the need to reclaim large acreages of tide and submerged land for industrial use will not arise until mature urban economies have developed near the potentially reclaimable areas.

A final important consideration is that, over and above the high cost of reclamation, the acceptance of such lands for certain industrial purposes is doubtful. Differential settlement of fill material in reclaimed land, especially where fills would have to be deep, would probably result in high maintenance costs for roads and water and gas facilities, and it might also occasionally require major reconstruction of some buildings. Differential settlement has been a problem at the San Francisco International Airport and the Bayshore Freeway, where marshland was first drained and then filled. Its effects may now be seen in some of the older buildings on lower Market Street in San Francisco and at the east end of the Bay Bridge.

It is estimated that, in 2020, the area of land beyond the present shoreline which will be in use for industrial purposes (including land for commercial airports, public utilities, and railroad emplacements) will be about 18 square miles. In comparison with the total amount of such land available, this is not much. Locally, however, such lands may become highly important as, for example, in the South San Francisco, San Lorenzo, Berkeley, and Richmond-Southern San Pablo Bay areas. (See ch. IV, and pl. 18, plate supplement.)

82. Reclamation for Residential Use

Unpublished information compiled in 1951 by the Housing and Home Finance Agency indicated that improvements on land developed for low-cost housing (eight units per acre) then averaged $6,700 an acre. Using the Engineering News-Record construction cost index as a guide, these same improvements today probably would cost in the neighborhood of $10,000 an acre.

With respect to reclamation of tide and submerged lands exclusively for residential uses, only high-density apartment projects could absorb the high costs of filling and improvement. Locally, such conditions may exist, and, as population growth continues in the Bay Area, other spots probably will show up where it will become economically feasible to reclaim tide and submerged lands exclusively for residential purposes. At this time, however, it appears doubtful that, within the foreseeable future, there will be a great demand for large-scale reclamation of tide and submerged lands exclusively for residential use.

83. Reclamation for Railroad Needs

Further development of railroad lines cannot be expected to involve any appreciable reclamation of tide and submerged lands. The only areas in which such reclamation for railroad facilities might occur is in possible future industrial areas; for example, parts of East San Francisco Bay between Richmond and the Bay Bridge and similar regions elsewhere in the three bays.

84. Reclamation for Highway Needs

If population in the Bay Area should increase from nearly 4 to over 14 million during the next six decades, it is certain that the need for high-speed freeways will increase considerably above and beyond what is planned at present for the near future, particularly as it appears likely that about 10 of the 14 million will be located fairly close to the three bays.

Flat, low areas close to the present shore may become highly attractive for construction of additional freeways. Such construction may become economically and socially feasible, especially if carried out in conjunction with extensive shore-improvement programs involving the development of land for many kinds of recreational and even some types of residential purposes. Such developments can be envisaged along the west and east shores of San Francisco Bay proper south of a line from Sierra Point to Roberts Landing, and eventually perhaps across the northern part of San Pablo Bay. Multipurpose plans of this type would entail a certain amount of further reclamation of marshlands, but they very likely would involve reclamation also of tidelands and certain shallower portions of the submerged lands. At present it is impracticable to estimate how much land in each category eventually would have to be reclaimed for these purposes.

The planning commissions and departments of San Mateo, Santa Clara, and Alameda Counties are jointly considering shoreline development as an integrated type of development which will involve land reclamation.

85. Reclamation for Recreational and Associated Uses

As population in the Bay Area increases, the need for open spaces and land for recreational and associated uses also will increase, and land set aside for such purposes probably should increase more than proportionately.

On the land-use maps (see pls. 11–18, plate supplement), many of the public and reserved lands shown belong to the Federal Government or to institutions and are not for future recreational purposes. Other lands are watershed-protection areas for reservoirs, and public uses, if any, are apt to be somewhat limited. Thus the present areas set aside for recreational purposes represent only a fraction of the lands titled "Public and Reserved Land."

As mentioned above, there will be a material need to increase greatly the total square mileage available for recreational purposes in the Bay Area. The extent to which this should be done falls outside the scope of this report, except for one aspect. Millions of people around the three bays are going to look more and more to the water areas for some of their recreational needs. Boating, fishing, and hunting of waterfowl are among the most popular forms of recreation of the American public, more so than hiking and camping. Picnicking, another form of popular recreation, while pleasant in wooded parks and on hilly terrain, may also be very satisfying in suitably developed waterfront areas.

Preliminary plans for waterfront development in San Mateo and Santa Clara Counties are multipurpose in nature and include not only new highways, of the parkway type, but also safe waters for small boats, facilities for larger boats, picnicking areas, nature areas, docking areas, and boat-repair facilities. Needs for such associated recreation items will be great, and if the plans mentioned and other plans are to come to fruition, reclamation of certain marshlands and tidal areas, and even of shallower parts of the submerged lands, will be necessary.

Total reclamation needs for recreational purposes eventually may well exceed the possible total for all the other purposes discussed earlier. The extent of changes in the present shoreline of the three bays as a result of such development should depend not only upon what will prove to be socially justifiable and economically feasible during coming decades, but also on what should be set as the desirable minimum water area of the present three bays.

Appendix A. Area Density Method

A–1. PURPOSE

This section describes the Area Density Method and presents an analysis comparing the area-density population projections with population projections based on Office of Area Development estimates of future employment.

A–2. AREA DENSITY METHOD

(*a*) *New method for projecting and distributing population for small areas.*—Small areas within as large an area as is under study in this report grow at different times and at different rates. This is so because small areas have differing potentials and prospects for growth due to such factors as availability of land and location of the areas. For this reason, it was deemed necessary to develop a method for projecting and distributing population which would, insofar as possible, reflect these differences in growth potential of small areas. The need was to develop a set of basic growth guides and rates which could be applied in projecting population for townships but which, at the same time, would take into account the differences in growth patterns and rates which had been observed, not only in the San Francisco Bay Area, but also in other cities of the United States. To meet this need there was developed a new method for projecting and distributing population—the Area Density Method.

The Area Density Method is fundamentally an extrapolation of past experience with adjustments for foreseeable events in the future. The method projects in area as well as in time, and it distinguishes between calculated trends and elements of judgment. It also involves special studies as indicated in chapter II. (See pp. 15–16.)

(*b*) *Advantages of Area Density Method.*—This method has five specific advantages:

(1) It makes possible population estimates for small areas (minor civil divisions) within a metropolitan area.

(2) It permits estimates at different points of time (as by decades) rather than at one terminal date with no estimates for intervening years.

(3) It takes into account and classifies the various types of local small-area growth patterns within the present urbanized areas and projects these patterns or profiles of growth for the appropriate nonurbanized portions of the metropolitan area on the basis of economic and geographic similarities and in light of the rate of spread of the urban complex as a whole.

(4) It facilitates correction or adjustment of projections to conform with new information and new trends.

(5) The breakdown by small areas permits correction for certain areas without affecting the others.

(*c*) *Steps in method.*

(1) Step 1 involved development of density estimates for each township of the Bay Area for the base year, 1960. This was done by using the most recent population estimate, calculating the mean annual rate of density change, and extending this rate to 1960.

Basic data and estimates used included the 1940 Census of Population of the United States and the most current population estimates available from school district files, county master plans, the State chambers of commerce, the State of California Department of Finance, and private research organizations. Such data were available for 73 percent of the townships. For the remaining townships, the most recent material was from the 1940 and 1950 U.S. Population Censuses, and the rate for this period was used for them.

The base year 1960 was used because of its proximity and the belief that current rates seemed likely to approximate the results of the forthcoming 1960 Census of Population of the United States.

(2) Step 2 involved development of five growth-rate categories (listed top of p. A–2). A standard curve of density increase was established by using all data obtainable for township densities for the period 1900–1950. From the 1940 Census of Population of the United States township areas for 1940 were obtained to calculate the densities. Where the area of an individual township in decades previous to 1940 differed from the area in 1940, population densities for those earlier decades were excluded from consideration.

These density figures were arrayed in order of decreasing size, and the array was divided, by inspection, into five categories. The density changes ranged from 4,979 to −114. Of the 181 figures obtained, only 6 were above 1,776 and only 1 was lower than −39. These seven figures were treated as exceptions and set aside. The high anomalies were not considered because they seemed subject to explanation by special reasons which could not be assumed to be repeatable according to any set pattern; the low anomaly was disregarded because of its unique position outside the overall array of density changes.

The remaining density changes were divided and categorized as follows: A (1,776 to 708), B (707 to 187), C (186 to 32), D (31 to 20), and E (19 to −39).

The mean density of each category was then determined—A = 1,080.1, B = 363.8, C = 88.3, D = 26.1, E = 2.8—and each category given a title: "Very Rapid Growth," "Rapid Growth," "Gradual Growth," "Slow

Growth," and "Very Slow Growth," respectively. (See following listing.)

Category	Mean density increment per square mile per decade	Title of rate change
A	1, 080. 1	Very Rapid Growth.
B	363. 8	Rapid Growth.
C	88. 3	Gradual Growth.
D	26. 1	Slow Growth.
E	2. 8	Very Slow Growth.

(3) Step 3 involved development of the rate of density increase. Next to each township's decennial change in density was placed the letter designating the appropriate category (as was determined in step 2) for the period 1900–1950. Using this information together with similar data for 62 other cities of the United States with populations of 2,500 or more, a most probable duration of each growth rate was determined and a "normal sequence of growth" was established; for example: E–E–E–D–D–C–C–B–B–B–A–A–A.

It was found that, in the Bay Area as well as in other cities of the United States, normally three or more decades of Rapid Growth (B) are preceded by two or three decades of Gradual Growth (C) which, in turn, are preceded by two decades of Slow Growth (D). Very Rapid Growth (A) was assumed for well-developed central places, peripheral areas of the central cities, and sites and occurrences of major industrial expansion where three or more decades of Rapid Growth (B) had already taken place. This "normal sequence of growth" was used in estimating the most likely rates of growth in the various townships in different decades.

(4) Step 4 involved development of density projections. With 1930 as a takeoff point, the decennial projections were made using the "normal sequence of growth" rate (formulated in step 3) and correcting for permutations which occurred sporadically between the actual and projected changes in density from 1930 to 1960. Each township's growth pattern for 1930–60 was compared with the "normal sequence of growth," and careful consideration was given those areas which deviated from the established pattern. With these considerations in mind, the extrapolations were then carried out to 2020 following the "normal sequence of growth."

In order to check these township extrapolations, a method of geographical displacement was collated at the point in time where the Rapid Growth rate began. (See p. A–4.) The map of projected "Growth Lines, 1950–2010" (see pl. 2, plate supplement) is concerned with the Rapid Growth rate (363.8 per-decade density increase), although it could have been constructed to describe any other of the five growth-rate categories.

The date of Rapid Growth used in the "normal sequence of growth" rate concurred with the date of Rapid Growth rate on the map of projected "Growth Lines, 1950–2010" in almost every instance. Where the dates did not agree, the township was studied (by local interview) to determine what local developments, plans, or trends were responsible for the difference in the dates set for Rapid Growth by the Growth Lines map and by the "normal sequence of growth" patterns. Upon evaluation of the information obtained locally concerning the outbreak for Rapid Growth, a Rapid Growth rate decade was selected.

One further consideration was made in preparing the projected densities. On the basis of evidence revealing the cyclical pattern of economic fluctuation, the projections assumed a lower rate of density growth increase about every 30 years. (See p. 17, ch. II.)

To allow for an assumption that there would probably be two periods of slower economic growth over the next 60 years, one density-change rate lower than normally would have occurred was used for the periods 1960–70 and 1990–2000. (See p. 17, ch. II.)

(5) Step 5 involved development of a density-change table. Table A–1 was constructed, using the letter designators (A, B, C, D, and E) which described the change in density for each township, by decades, from 1960 to 2020.

The "normal sequence of growth" was used, with the following exceptions:

(*a*) The rates for the years 1960–70 and 1990–2000 were reduced one category lower than would have been appropriate to the "normal sequence of growth." The stipulation was made to allow for two periods of slower economic growth (explained in step 4).

(*b*) For certain townships—for example, Vallejo and Port Chicago, which were observed to have eccentric growth patterns—divergence from the "normal sequence" was introduced.

(*c*) If there was a conflict between the "normal sequence of growth" and the map of projected "Growth Lines, 1950–2010" in determining the Rapid Growth rate period (as described in step 4), a decision on which growth rate to use was made after consideration of any local developments, plans, and trends which would influence the future growth rates of individual townships. Where the decision was made against the "normal sequence of growth" projection, the decades before the Rapid Growth rate period also had to be adjusted contrary to the "normal sequence of growth" to provide for the growth expectations developed in the overall study of the local situation.

Table A–1 was used as the basic guide for making the township density projections. Should disagreement develop concerning the date of Rapid Growth for any township, reconciliation can be made by selecting the growth rates considered most applicable to the changing situation. Readjustments are feasible at any time, making it possible to maintain up-to-date projections.

(6) Step 6 involved testing the reasonableness of projected densities. The actual 1950 and projected 2020 population densities for the Bay Area townships were compared with 1950 population densities of townships in the urban and suburban areas of New York, Chicago, Philadelphia, Washington, D.C., Boston, Kansas City, Mo., Houston, Los Angeles, and Wilmington, Del.

Comparison of the greatest projected population densities for the Bay Area for 2020 with the densities already experienced by 10 Bay Area townships and with densities of other townships of similar size in other areas is shown in table 10, chapter II. It shows that all projected Bay Area population densities lie within the range of currently observable densities in the United States.

Table A–1.—Projected Rate of Population Density Change by Standard Categories for Townships in San Francisco Bay Area

KEY

A=1080.1 per decade density increase (Very Rapid Growth).
B=363.8 per decade density increase (Rapid Growth).
C=88.3 per decade density increase (Gradual Growth).
D=26.1 per decade density increase (Slow Growth).
E=2.8 per decade density increase (Very Slow Growth).

County and township	1960–1970	1970–1980	1980–1990	1990–2000	2000–2010	2010–2020
Alameda:						
Alameda	B	A	A	B	A	A
Brooklyn	B	A	A	B	A	A
Eden	B	A	A	B	A	A
Murray	D	C	C	C	B	B
Oakland-Peralta	B	A	A	B	A	A
Pleasanton	D	C	B	C	B	B
Washington	C	B	B	B	A	A
Contra Costa:						
Township 1, Martinez	C	B	B	B	A	A
Township 2, Port Costa	D	C	C	C	B	B
Township 3, Walnut Creek	B	C	B	B	A	A
Township 4, Danville	D	B	B	C	B	A
Township 5, Concord	B	B	A	B	A	A
Township 6, Pittsburg	C	B	A	B	A	A
Township 7, El Cerrito	B	A	A	B	A	A
Township 8, Antioch	C	B	B	C	B	A
Township 9, Brentwood	E	C	C	D	B	B
Township 10, El Sobrante	C	B	B	B	A	A
Township 11, Pinole	C	B	B	B	B	A
Township 12, Crockett	D	B	B	C	B	A
Township 13, Mount Diablo	E	E	D	E	D	D
Township 14, Byron	D	C	C	C	B	B
Township 15, Richmond	B	A	A	B	A	A
Township 16, Port Chicago	D	B	C	C	A	B
Township 17, Oakley	D	C	B	C	B	B
Marin:						
Novato	C	C	C	C	B	B
San Rafael	C	B	B	B	A	A
Sausalito	C	B	B	C	B	B
Tomales	E	D	C	D	C	C
Napa:						
Calistoga	E	E	D	D	C	C
Napa	D	C	C	C	B	B
St. Helena	E	E	C	D	C	C
San Francisco:						
San Francisco	A	A	A	A	B	B
San Mateo:						
Township 1, South San Francisco	B	A	A	B	A	A
Township 2, Belmont	B	A	A	B	A	A
Township 3, Redwood City	C	B	B	C	A	A
Township 4, Half Moon Bay	D	D	C	C	B	B
Township 5, Burlingame	B	A	A	B	A	A
Santa Clara:						
Burnett	D	C	C	C	B	B
Campbell	B	B	A	B	A	A
Fremont	B	B	B	B	A	A
Gilroy	C	C	C	C	B	B
Palo Alto	A	A	B	B	A	B
Redwood	C	C	B	C	A	A
San Jose	C	B	B	C	B	B
Santa Clara	B	A	A	B	B	A
Saratoga	C	B	B	B	A	A
Sunnyvale	A	A	B	C	B	A

Table A-1.—Projected Rate of Population Density Change by Standard Categories for Townships in San Francisco Bay Area—Continued

County and township	1960–1970	1970–1980	1980–1990	1990–2000	2000–2010	2010–2020
Solano:						
Benicia	D	B	B	C	A	A
Denverton	E	D	C	D	C	B
Elmira	E	C	C	C	B	B
Green Valley	D	C	C	C	B	B
Maine Prairie	E	C	C	D	B	B
Montezuma	D	C	B	C	B	B
Rio Vista	D	C	C	C	B	B
Silveyville	D	D	C	C	B	B
Suisun	D	C	C	C	B	B
Tremont	D	C	B	C	B	B
Vacaville	D	C	C	D	B	B
Vallejo	C	B	B	B	A	A
Sonoma:						
Analy	D	C	C	C	B	B
Cloverdale	E	D	D	D	C	C
Healdsburg	E	D	D	D	C	C
Petaluma	D	C	B	C	B	B
Redwood	E	E	E	E	D	D
Santa Rosa	C	B	B	C	B	B
Sonoma	D	C	C	C	B	B

(7) Step 7 involved preparation of a growth-lines map. As a guide to estimating the probable date at which a township might be expected to change its rate of population growth, a study of past growth rates of all Bay Area townships for the period 1900–1950 was made. The study was directed to determining—

(*a*) the rate of outward movement of lines of equal rate (growth lines of equal rate are lines which connect those points of population growth which are progressing at the same rate at a specific point in time);

(*b*) the conditions which accelerated or deflected these lines to permit a graphical extrapolation into the future of the present geographical distribution of growth rates; and

(*c*) an hypothesis of growth so formulated as to permit critical evaluation.

From this analysis, it was concluded in a very general sense that the line of Rapid Growth rate change (363.8 per decade density increase) moved outward at about 6 miles per decade, the line of Gradual Growth rate change (88.3 per decade density increase) moved outward at about 17 miles per decade, and the line of Slow Growth rate change (26.1 per decade density increase) moved outward at about 25 miles per decade.

These values, however, are to be considered only very general for describing the present or as guides to the future because of the shaping effects of hills, marshes, water bodies, plains, transportation corridors, bridges, and reserved lands, which significantly distort any picture of single radial growth.

For purposes of generalization, the rate of displacement of these limits was assumed to be about 6 miles per decade (considering the Rapid Growth rate only), with recognition that, in places, this rate might vary between 1 mile and 15 miles or even more. This figure (6 miles per decade) was used for guidance in locating the projected growth lines. It should be noted that there can be wide variances in direction and irregular progressions of growth between decades.

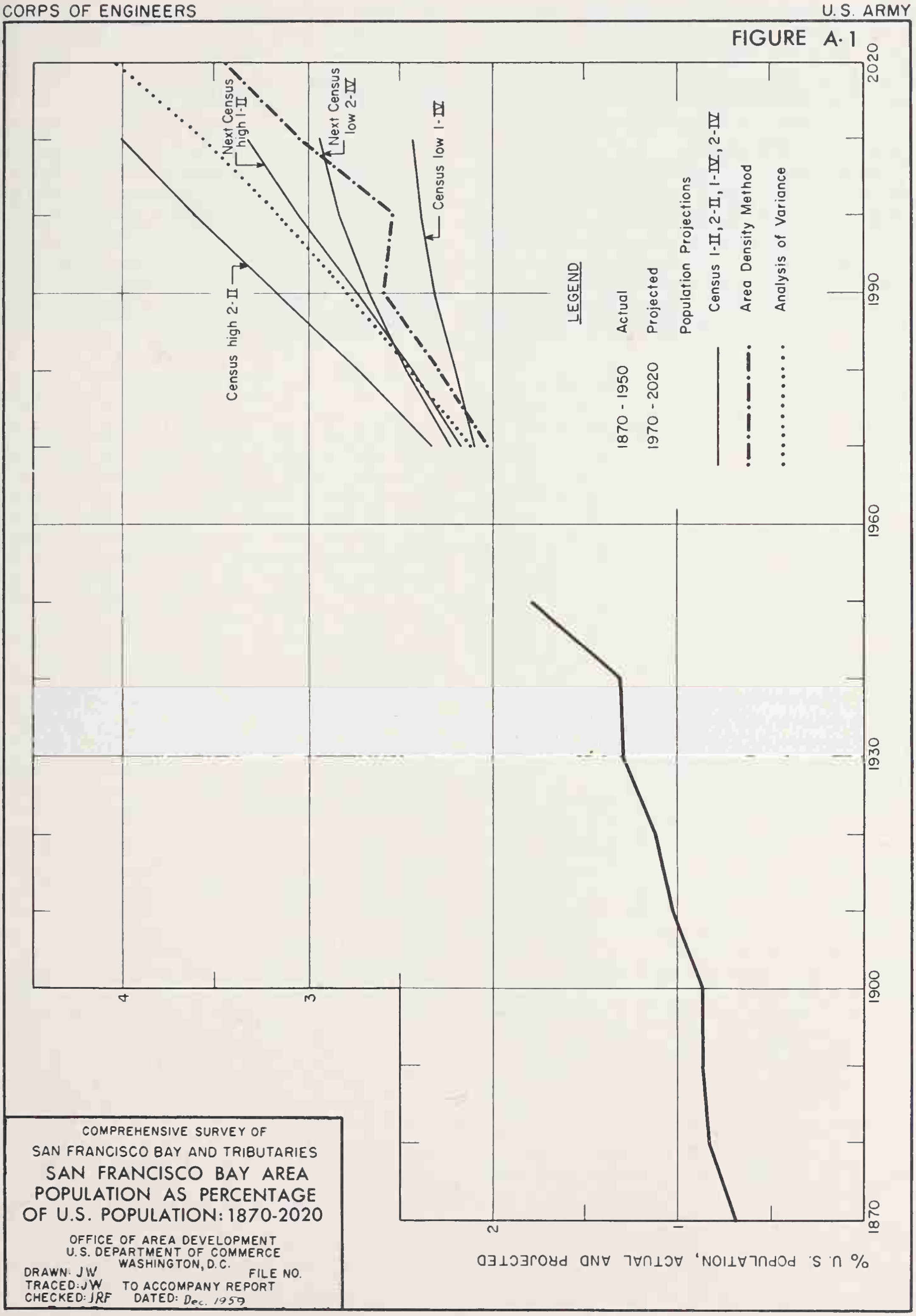
In preparation of the map of projected "Growth Lines, 1950–2010," two points of judgment were required.

(*a*) When two or more Rapid Growth lines originating at different places and bearing different dates crossed into a township, a judgment had to be made as to which date of Rapid Growth should be taken.

(*b*) Estimates had to be made of the probable divergence from the 6-mile rate, as caused by local conditions. The 6-mile rate was expanded along main transportation routes and areas of land well suited for urban and industrial uses. The rate was reduced in rough terrain, swamps and marshes, water bodies, about large areas of reserved land, and, in general, areas poorly suited to urban and industrial development because of local conditions. Coordination with the land-use study was effected, and adjustments were made on the growth-lines map as indicated.

A–3. CHECK OF POPULATION PROJECTIONS AGAINST PROJECTED U.S. POPULATION GROWTH

Plausibility of the recommended Area Density Method population projections has been further checked by comparing those values as a percentage of projected U.S. population growth. The results of these ratio comparisons are plotted on figure A–1, whereon the ratios of past populations of the Bay Area to total U.S. population are plotted by decades from 1870 to 1950. From 1970 to 2020, the ratios of the several projected curves are expressed as a percentage of future U.S. populations as projected by the Office



COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES

SAN FRANCISCO BAY AREA
POPULATION AS PERCENTAGE
OF U.S. POPULATION: 1870-2020

OFFICE OF AREA DEVELOPMENT
U.S. DEPARTMENT OF COMMERCE
WASHINGTON, D.C.

DRAWN: JW
TRACED: JW
CHECKED: JRF

FILE NO.
TO ACCOMPANY REPORT
DATED: Dec. 1959

of Business Economics (OBE), U.S. Department of Commerce (159). (For further discussion, see p. B–5, app. B.) Since the OBE projections do not include populations for 1960, no points are plotted for that decade. The denominator used for 2020 is an extrapolation of the Office of Business Economics projected populations for earlier decades.

Figure A–1 includes a curve for analysis of variance which was not incorporated in figure 6, chapter II. This curve is based on an equation that measures the tendency of the San Francisco Bay Area population over the period 1890 to 1950 to change in the same direction as the U.S. population over the same period. On the basis of this equation and assumptions of OBE projections for future U.S. populations, the probable San Francisco Bay Area population was computed for decades to 2020. These computed Bay Area population values were then taken as a percentage of the OBE projected values. These ratios are plotted on figure A–1.

Figure A–1 indicates that, according to the recommended population, the San Francisco Bay Area's share of the total U.S. population will continue to rise. It shows, too, that the rates of increase from decade to decade will be of modest proportions which, in general, approximate the average of all the several ratio curves.

From the foregoing analysis, it is concluded that the populations projected by the Area Density Method constitute a conservative and generally acceptable basis for the San Francisco Bay Area.

Appendix B. Previous Population Projections

B–1. PURPOSE

This section summarizes the key findings of the Office of Area Development's evaluation of previous projections made for the Bay Area and California, and it presents U.S. Bureau of the Census population projections including statements of assumptions made for each series and a general discussion of assumptions regarding migration, fertility, and mortality.

B–2. EVALUATION SUMMARY OF PREVIOUS POPULATION PROJECTIONS

Before population projections were prepared for the San Francisco Bay Area and its nine constituent counties (Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma), a review was made of population data and projections already developed by other sources. This review encompassed the 17 available projections of future population for the Bay Area, its individual counties, and the State of California.

Of these 17 projections, most were statewide or regional in coverage and failed to provide data on a county basis. Most, too, did not extend further into the future than 1970 or 1975. For these reasons, attention was directed to four projections which did consider Bay Area population up to the year 1990 and beyond. Detailed descriptions of these four projections appear in "Economic Aspects of Survey for the Comprehensive Development of San Francisco Bay and Tributaries, Part I: Evaluation of Existing Population Projections."

Figure B–1 presents findings of the four selected population projections: San Francisco Bay Area Rapid Transit Survey (base year, 1954; projections, to 1990, by 10-year intervals); State of California Division of Water Resources Report (base year, 1990; projections, 1990, 2000, 2010); East Bay Municipal Utility District Report (base year, 1940; projections, to year 2000); and Hetch Hetchy Water Supply Report (base year, 1910; projections, to 2000, by 10-year intervals). As figure B–1 indicates, projections for the year 2000 range from a low of 3,100,000 (Hetch Hetchy) to a high of 8 million (California State Division of Water Resources—high value). Summary notes on each of the four projections follow.

(*a*) *San Francisco Bay Area Rapid Transit Survey.*—These projections were prepared for the firm of Parsons, Brinckerhoff, Hall & Macdonald as part of background information to accompany and support proposals for the improvement of mass-transportation facilities in the Bay Area. The "high" series reflects a continuously expanding economy and favorable conditions of growth, while the "low" series reflects a less favorable economic background resulting in only moderate growth. To make the projections, the component (natural increase—net migration) method was employed except for the years 1980 and 1990. For these years, overall Bay Area totals were apportioned among the counties on the basis of past trends, using the ratios of their present population to Bay Area totals.

This method is considered sound and, with its stress on inmigration as one of the most important factors in future area growth, it appears particularly valid for California and the Bay Area. At the same time, it is noteworthy that recent data indicate actual growth is approximating the high projections more closely than the low figure and, if current trends continue, is likely to exceed even the high figure.

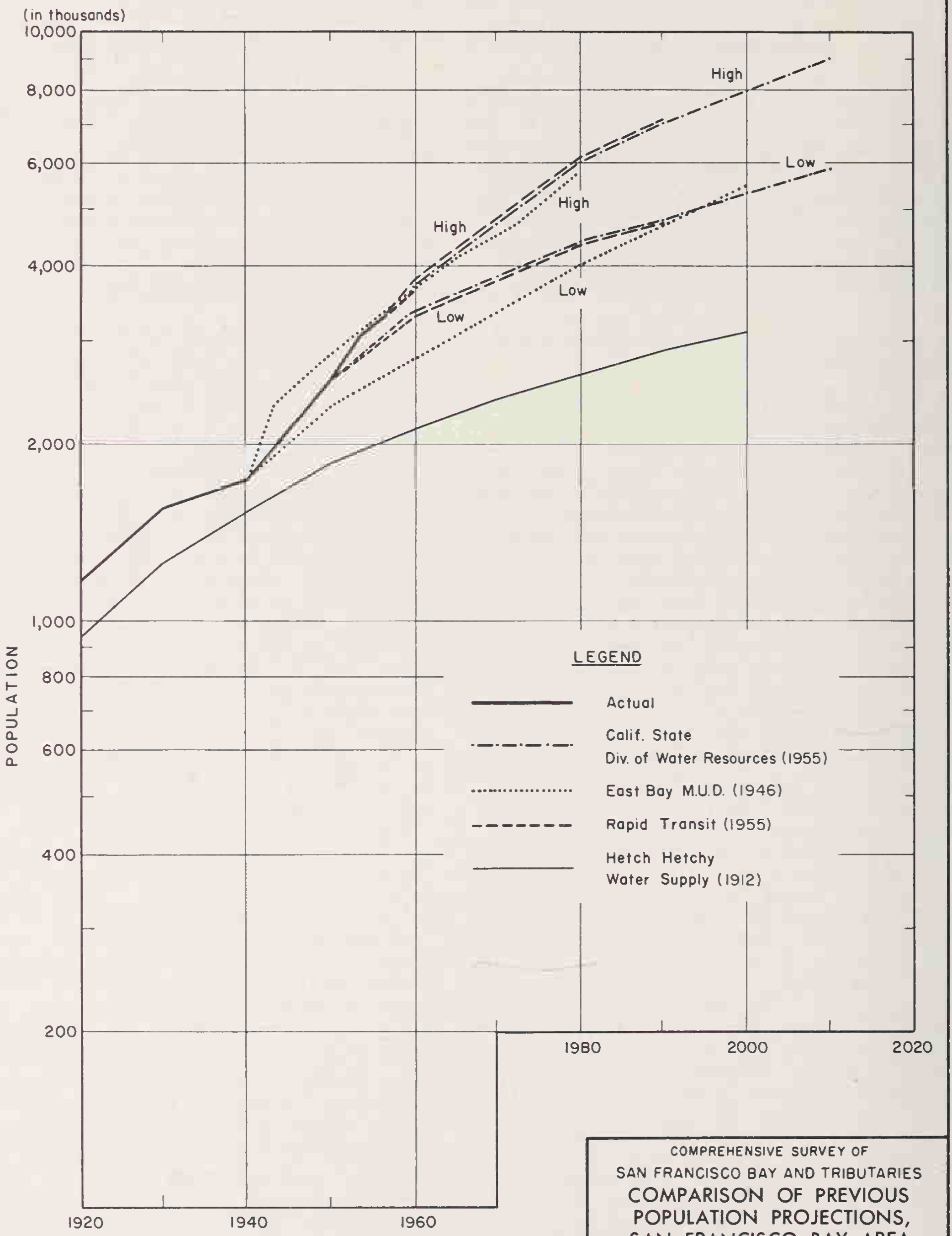
(*b*) *State of California Division of Water Resources Report.*—This report was prepared as background information for determining future water requirements, and in connection with a study of the feasibility of salt-water barriers, in the San Francisco Bay Area. It concluded that the Bay Area population in 2010 would be between 5,800,000 and 9 million, but most probably about 7,250,000. Population for each projection period was distributed within the counties in accordance with information on land characteristics, population densities, and directions of population expansion. The projections are essentially those of the Rapid Transit Survey because the Division of Water Resources accepted the assumptions inherent in the former survey and extended the trends it had established.

(*c*) *East Bay Municipal Utility District Report.*—These projections were prepared as background material for determination of future water requirements. While the Municipal Utility District report's "high" projections have been quite close to the actual population growth of the Bay Area since 1940, these projections were not used. It was believed necessary, in preparing projections for purposes of this report, to utilize additional assumptions pertaining to economic trends in the Nation, California, and the Bay Area.

(*d*) *Hetch Hetchy Water Supply Report.*—These projections were prepared to demonstrate a need for the then proposed Hetch Hetchy reservoir and aqueduct system for San Francisco. The resulting data paralleled remarkably the actual growth of the Bay Area for a period of 30 years (1910–40). For the period following 1940, however, these projections have diverged widely from actual population growth. Largely for this reason, they were not recommended for current planning purposes.

CORPS OF ENGINEERS U. S. ARMY

FIGURE B-1



COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES
COMPARISON OF PREVIOUS
POPULATION PROJECTIONS,
SAN FRANCISCO BAY AREA

OFFICE OF AREA DEVELOPMENT
U. S. DEPARTMENT OF COMMERCE
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DATED: Dec. 1959

(*e*) *Conclusion.*—Review of the foregoing population projections led to the conclusion that the "high" projections to the year 1990 in the San Francisco Bay Area Rapid Transit Survey, extended to the year 2010 by the report of the California State Division of Water Resources, were the best available at the time. Therefore, it was recommended that the Rapid Transit Survey projections be used for preliminary planning operations. At the same time, it was cautioned that, in consideration of the revised National and State population forecasts made more recently by the U.S. Bureau of the Census and the California State Department of Finance,[1] the Rapid Transit Survey projections for the Bay Area might be low in terms of long-range planning needs.

B-3. BUREAU OF CENSUS PROJECTIONS

(*a*) *Projections prepared.*—Following evaluation by the Office of Area Development of previous San Francisco Bay Area and California projections (see above discussion), the Bureau of the Census was requested to prepare population projections under differing assumptions to the year 2010 for the purpose of establishing the possible ranges for future National, State, and Bay Area population growth. The estimates and projections prepared by the Bureau of the Census (see tables B-1 and B-2) were:

(1) Estimates of the 1956 population of the United States, California, and of the Bay Area. (See table B-2, 1956 column.)

(2) Two projections of population for the Nation under differing assumptions, by decades, from 1960 to 2010. (See table B-1, United States Series 1-II and Series 1-IV.)

(3) Four projections of population for California under differing assumptions, by decades, from 1960 to 2010. (See table B-1, California Series 1-II, 2-II, 1-IV, and 2-IV.)

(4) Four projections of population for the Bay Area under differing assumptions, by decades, from 1960 to 2010. (See table B-1, San Francisco Bay Area Series 1-II, 2-II, 1-IV, and 2-IV.)

(5) Projections of population for the Bay Area counties, by decades, from 1960 to 2010. (See table B-2, Bay Area Counties Series 1-II, 2-II, 1-IV, and 2-IV.)

A discussion of assumptions relating to each of the projections appears on pp. B-5—B-8.

(*b*) *Projection summary.*—Table B-1 summarizes Bureau of the Census projections for the United States, California, and the San Francisco Bay Area, 1960-2010. (For Bureau of the Census county projections, see table B-2.)

Figure 5, chapter II, shows the differences in the Census Series 1-II—high national projection (458,464,000 for 2010), and the Census Series 1-IV—low national projection (327,199,000 for 2010), and the Office of Business Economics projection of 370 million for 2010 (extrapolated to 418 million for 2020 by the Office of Area Development). The differences in the three national projections result from differing assumptions: a high birth rate was assumed for Series 1-II, the Census high projection, and a low birth rate was assumed for Series 1-IV, the Census low projection. (See p. B-5.)

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[1] Unpublished tables, dated July 1, 1956, and July 1, 1957, obtained from the California State Department of Finance.

Table B-1.—Bureau of the Census Population Projections for the United States, California, and San Francisco Bay Area: 1960-2010 [1]

[In thousands]

Series	1960	1970	1980	1990	2000	2010
United States:						
Series 1-II	179, 226	212, 910	259, 081	314, 706	380, 801	458, 464
Series 1-IV	178, 520	201, 641	229, 934	260, 869	292, 194	327, 199
California:						
Series 1-II	15, 361	20, 606	28, 235	37, 629	48, 672	61, 026
Series 2-II	15, 351	20, 499	27, 994	37, 211	48, 041	60, 166
Series 1-IV	15, 306	19, 684	25, 415	31, 773	38, 161	44, 587
Series 2-IV	15, 296	19, 587	25, 210	31, 439	37, 694	43, 994
San Francisco Bay Area:						
Series 1-II	3, 510	4, 594	6, 040	7, 840	9, 949	12, 331
Series 2-II	3, 635	4, 906	6, 738	9, 044	11, 759	14, 789
Series 1-IV	3, 498	4, 387	5, 430	6, 608	7, 785	8, 990
Series 2-IV	3, 622	4, 692	6, 073	7, 649	9, 237	10, 828

[1] For assumptions made for each series, see p. B-5.

Table B–2.—Bureau of the Census Population Projections for the United States, California, San Francisco Bay Area, and Bay Area Counties: 1960-2010[1] *(In 4 Series)*[2]

SERIES 1–II

[In thousands]

Area	1940[3]	1950[3]	1956[4]	1960	1970	1980	1990	2000	2010
United States	131, 669	150, 697	167, 259	179, 226	212, 910	259, 081	314, 706	380, 801	458, 464
California	6, 907	10, 586	13, 471	15, 361	20, 606	28, 235	37, 629	48, 672	61, 026
Bay Area total	1, 735	2, 682	3, 175	3, 511	4, 594	6, 040	7, 840	9, 949	12, 331
Alameda	513	740	846	904	1, 116	1, 345	1, 612	1, 918	2, 281
Contra Costa	100	299	343	386	555	765	1, 017	1, 304	1, 622
Marin	53	86	114	133	186	259	346	446	557
Napa	29	47	63	74	100	171	263	375	504
San Francisco	635	775	742	720	740	740	767	822	918
San Mateo	112	236	346	423	635	791	969	1, 158	1, 345
Santa Clara	175	291	469	589	886	1, 352	1, 945	2, 640	3, 401
Solano	49	105	119	130	174	282	416	576	759
Sonoma	69	103	133	152	202	335	505	710	944

SERIES 2–II

Area	1940[3]	1950[3]	1956[4]	1960	1970	1980	1990	2000	2010
United States	131, 669	150, 697	167, 259	179, 226	212, 910	259, 081	314, 706	380, 801	458, 464
California	6, 907	10, 586	13, 471	15, 351	20, 499	27, 994	37, 211	48, 041	60, 166
Bay Area total	1, 735	2, 682	3, 175	3, 634	4, 906	6, 738	9, 044	11, 759	14, 789
Alameda	513	740	846	954	1, 249	1, 649	2, 176	2, 804	3, 508
Contra Costa	100	299	343	431	684	1, 097	1, 687	2, 424	3, 244
Marin	53	86	114	130	177	242	328	430	546
Napa	29	47	63	71	93	139	204	287	377
San Francisco	635	775	742	799	947	1, 134	1, 200	1, 200	1, 200
San Mateo	112	236	346	415	607	809	1, 053	1, 326	1, 613
Santa Clara	175	291	469	541	743	1, 026	1, 405	1, 857	2, 362
Solano	49	105	119	143	212	356	573	851	1, 174
Sonoma	69	103	133	150	194	286	418	580	765

SERIES 1–IV

Area	1940[3]	1950[3]	1956[4]	1960	1970	1980	1990	2000	2010
United States	131, 669	150, 697	167, 259	178, 520	201, 641	229, 934	260, 869	292, 194	327, 199
California	6, 907	10, 586	13, 471	15, 306	19, 684	25, 415	31, 773	38, 161	44, 587
Bay Area total	1, 735	2, 682	3, 175	3, 498	4, 387	5, 430	6, 608	7, 785	8, 990
Alameda	513	740	846	901	1, 066	1, 209	1, 358	1, 501	1, 663
Contra Costa	100	299	343	385	528	684	851	1, 012	1, 173
Marin	53	86	114	133	178	234	293	351	409
Napa	29	47	63	73	97	157	229	304	382
San Francisco	635	775	742	717	707	665	647	644	670
San Mateo	112	236	346	421	606	712	816	906	980
Santa Clara	175	291	469	587	846	1, 216	1, 640	2, 066	2, 479
Solano	49	105	119	130	165	249	343	438	536
Sonoma	69	103	133	151	194	304	431	563	698

Table B–2.—Bureau of the Census Population Projections for the United States, California, San Francisco Bay Area, and Bay Area Counties; 1960–2010[1] *(In 4 Series)*[2] -- Continued

Series 2–IV

[In thousands]

Area	1940[3]	1950[3]	1956[4]	1960	1970	1980	1990	2000	2010
United States	131, 669	150, 697	167, 259	178, 520	201, 641	229, 934	260, 869	292, 194	327, 199
California	6, 907	10, 586	13, 471	15, 296	19, 587	25, 210	31, 439	37, 694	43, 994
Bay Area total	1, 735	2, 682	3, 175	3, 622	4, 691	6, 073	7, 649	9, 237	10, 828
Alameda	513	740	846	951	1, 195	1, 495	1, 850	2, 195	2, 547
Contra Costa	100	299	343	430	652	992	1, 428	1, 888	2, 342
Marin	53	86	114	130	169	219	279	338	397
Napa	29	47	63	71	90	130	179	229	281
San Francisco	635	775	742	796	909	1, 000	1, 000	1, 000	1, 000
San Mateo	112	236	346	413	580	729	890	1, 042	1, 181
Santa Clara	175	291	469	539	708	926	1, 186	1, 441	1, 699
Solano	49	105	119	143	201	320	478	648	824
Sonoma	69	103	133	149	187	262	359	456	557

[1] Figures for 1956 to 2010 relate to July 1 and represent the resident population; i.e., including Armed Forces stationed in the area. U.S. figures exclude Armed Forces overseas.

[2] For assumptions made for each series, see p. B–5.

[3] Actual U.S. Census of Population.

[4] Estimate by Bureau of the Census.

The Office of Business Economics population projection (made to obtain a single population projection as a basis for estimating gross national product) assumes present birth rates for the next few years and a gradual decline in the birth rate to the 1940–42 average birth rate by 2010. The Office of Area Development used the Office of Business Economics projection to 2010 (370 million) as extrapolated by the Office of Area Development to 2020 (418 million) because this projection followed a middle ground between the Census high and low projections in the matter of birth rate assumptions. Furthermore, for purposes of this study, it was concluded that a middle-ground position with reference to national population projections was preferable to using either the high or low Census projections. In addition, as the Office of Business Economics projections were made for the purpose of estimating 2010 gross national product, the conclusion to use this projection allowed use of the Office of Business Economics gross national product projections for the economic phases of the report.

Figure B–2 presents Bureau of the Census population projections for California, 1960–2010, under different assumptions of birth rate. (See p. B–5.) The Office of Area Development believes the future population of California will incline to follow the higher projections (Series 1–II and 2–II) rather than the lower projections (Series 1–IV and 2–IV) because of the basic competitive advantages for new economic activity California enjoys. (See ch. III.)

Figure B–3 presents four projections by the Bureau of the Census for the San Francisco Bay Area, 1960–2010. These projections range from a low of 8,990,000 for 2010 to a high of 14,789,000 for 2010. The Census "high" projection for 2010 is more than 3½ million greater than the recommended population projection of 11,256,000 for 2010.

(*c*) *Projection assumptions.*—The assumptions made for each of the Census projections series were as follows:

(1) *Projection 1–II.*—A combination of the 1950–56 and 1940–56 migration was assumed. For the years to 1960, the 1950–56 levels were assumed to prevail. These levels were then assumed to change linearly so as to equal the 1950–56 average by 1970. The present national fertility level (1955–57) is expected to remain constant to 1975–80 (GRR[2] 1.79). Then fertility would decline from the 1975–80 level (GRR 1.79) to the 1949–51 level (GRR 1.54) by 2005–10. There is assumed a moderate decline in mortality throughout the projection period.

(2) *Projection 2–II.*—Levels of migration in the period 1940–50 were assumed to prevail throughout the projection period to 1970. The present national fertility level (1955–57) is expected to remain constant to 1975–80 (GRR 1.79). Then fertility would decline from the 1975–80 level (GRR 1.79) to the 1949–51 level (GRR 1.54) by 2005–10. There is assumed a moderate decline in mortality throughout the projection period.

(3) *Projection 1–IV.*—This involves the same migration assumption as in projection 1–II. The national fertility level of 1955–57 (GRR 1.79) is expected to decline to the 1942–44 level (GRR 1.28) by 1965–70 and remain at that level to 1975–80. State and county rates are tied in with national rates. Fertility is assumed to remain constant at its projected 1975–80 level (GRR 1.28) from 1980 to 2010. A moderate decline in mortality throughout the projection period is assumed.

(4) *Projection 2–IV.*—This involves the same migration assumption as in projection 2–II. The national fertility level is expected to decline from the 1955–57 level (GRR 1.79) to the 1942–44 level (GRR 1.28) by 1965–70 and remain at that level to 1975–80. State and county rates are tied in with national rates. Fertility is assumed to remain constant at its projected 1975–80 level (GRR 1.28) from 1980 to 2010. A moderate decline in mortality throughout the projection period is assumed.

(*d*) *General statement on assumptions.*

(1) *Migration.*—When making population projections for States and local areas, interstate and inter-

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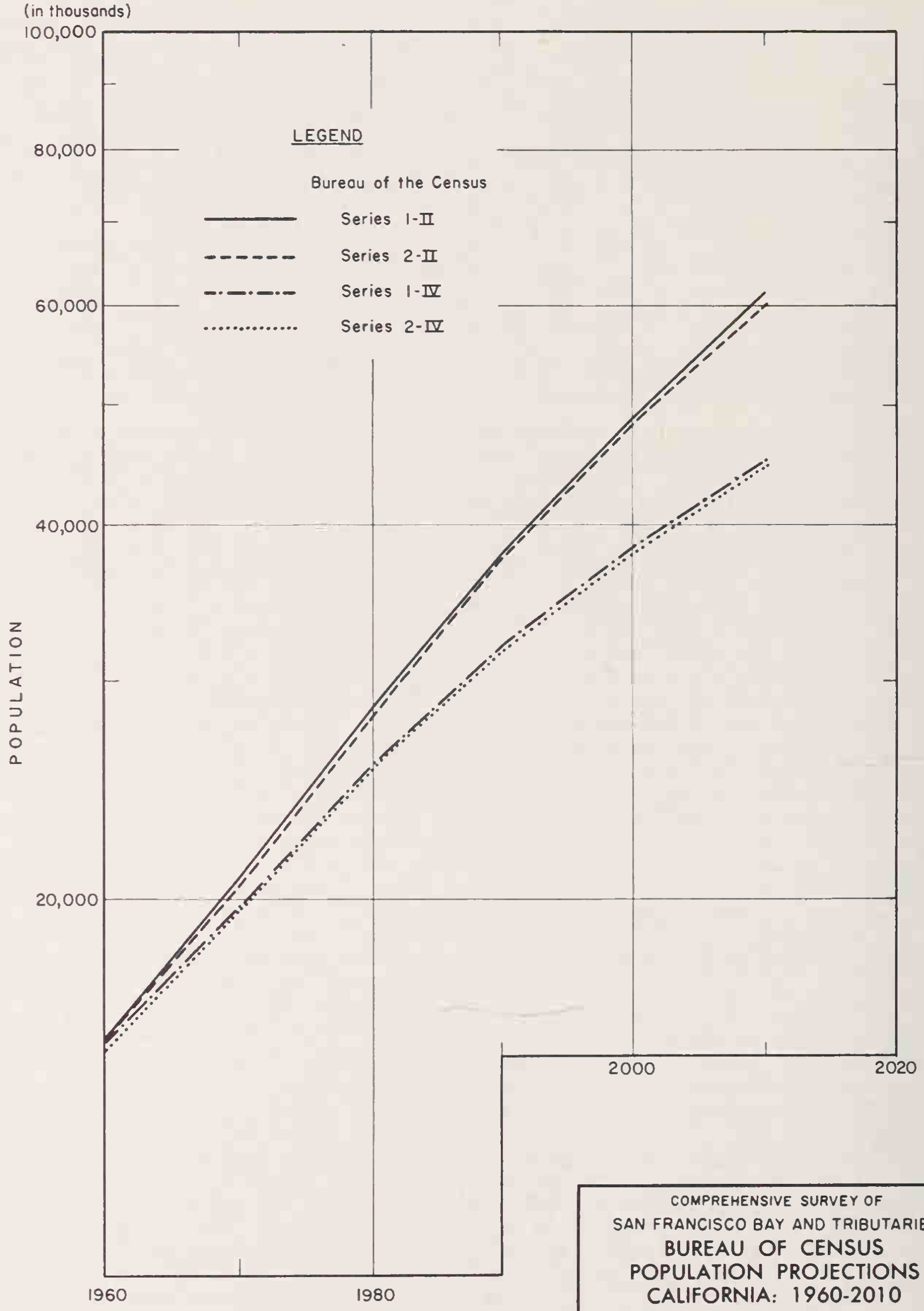
[2] See explanation of gross reproduction rate on p. B–8.

CORPS OF ENGINEERS U.S. ARMY

FIGURE B·2



COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES

BUREAU OF CENSUS
POPULATION PROJECTIONS
CALIFORNIA: 1960-2010

OFFICE OF AREA DEVELOPMENT
U.S. DEPARTMENT OF COMMERCE
WASHINGTON, D.C.

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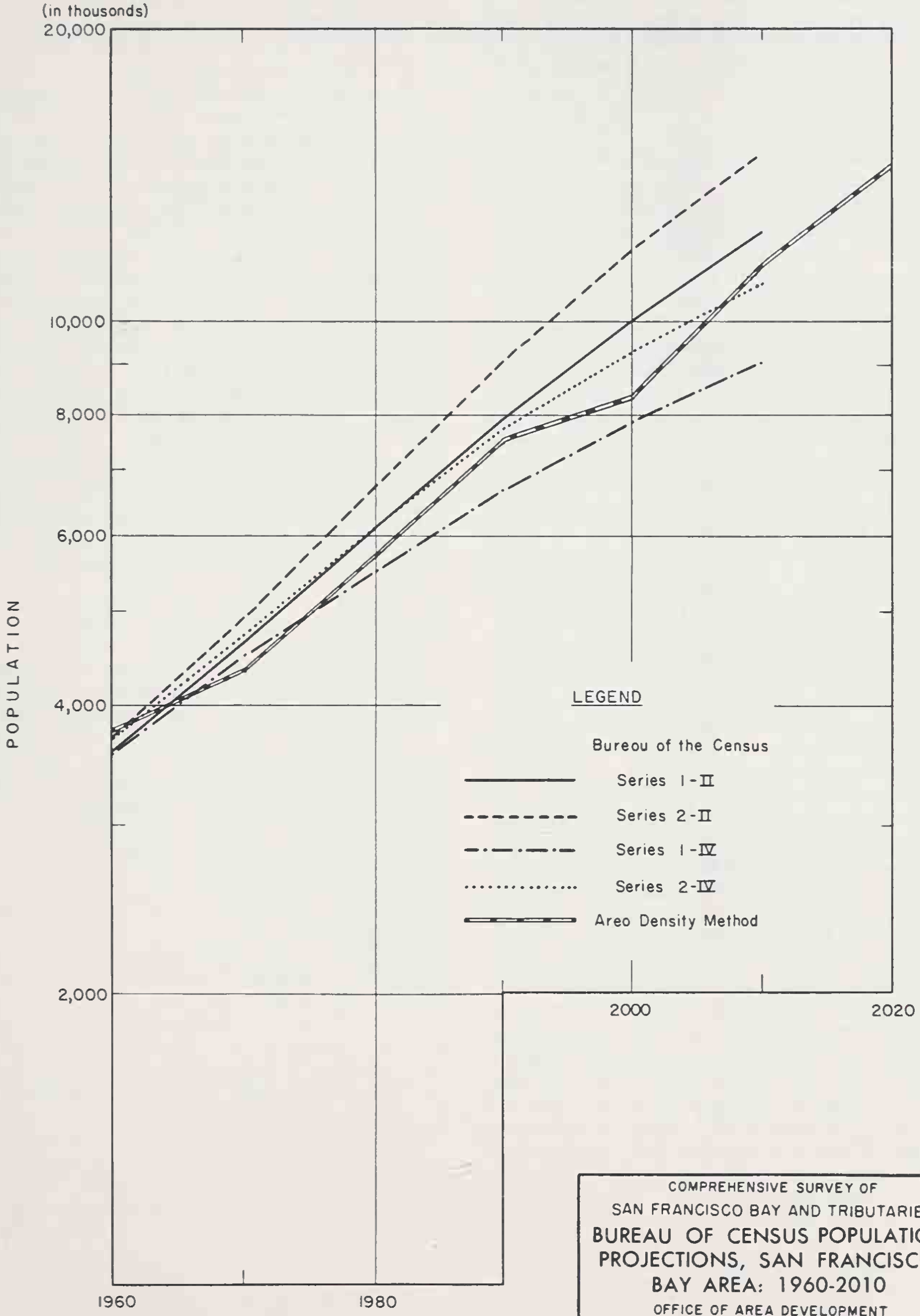
TRACED: JW TO ACCOMPANY REPORT
CHECKED: JRF DATED: Dec. 1959

CORPS OF ENGINEERS U.S. ARMY

FIGURE B·3



COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES

BUREAU OF CENSUS POPULATION PROJECTIONS, SAN FRANCISCO BAY AREA: 1960-2010

OFFICE OF AREA DEVELOPMENT
U.S. DEPARTMENT OF COMMERCE
WASHINGTON, D.C.

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county migration plays an important role. At present, the techniques available and the data necessary for determining the future level of such migration are still limited. Consequently, it has been necessary to rely on past trends as guides to future development. Such guides, although somewhat imperfect for measuring future potential, provide illustrative examples of the effect of various levels of migration on population growth in an area. In developing the population projections to 1970 in particular, it was considered reasonable to assume that the migration experience of the most recent past would continue for several more years without any abrupt reversals, and that over the next 15 years, migration will approximate the pattern of the past 15 years. This was determined by assuming that the recent migration level of the 1950–56 period would continue from 1956 to 1960 and then change slowly over the next 10 years toward the longer term patterns of the 1940–56 period, providing a smooth juncture of the levels for the two periods.

On the other hand, because of the uncertainty of future migration, it seemed advisable to incorporate at least one other alternative on future migration. Here, too, a past period—the 1940–50 decade—was used as a guide for the future. This use of 1940–50, although somewhat arbitrary, has the advantage of providing the latest firm estimate of net migration (based on the 1940 and 1950 U.S. Population Censuses) unaffected by the tentative estimates of the 1950–56 postcensal period. The estimated level and nature of the pattern of the latter appear, in many instances, to be quite different from the pattern of the preceding 1940–50 period and, as such, provide a useful alternative regarding future net migration. It should be noted at the same time that some of these changes may, in part, be a product of the relatively weak indicators used to measure current migration since 1950.

(2) *Fertility.*—The national fertility rates used as the basis for estimating future local fertility were not developed as "forecasts" of the most probable future outlook, but rather represent illustrative examples of future fertility under stated reasonable assumptions. For use here, two levels of future fertility were chosen from among four different series prepared by the Bureau of the Census, providing for the San Francisco Bay Area what appears to be a fairly reasonable range within which fertility is likely to fall. On one hand, at the upper level, it provides for a continuation of the 1955–57 levels to 1975–80 and then a small gradual decline to the 1949–51 level by 1995–2000—a decline of about 15 percent over the 30-year period. The implied estimated ultimate GRR [3] (gross reproduction rate) of 1.54 still indicates a fertility level of more than three children born per woman, a level which may be difficult to maintain over the next 50 years in light of the long-term trend in fertility, but which supplies a satisfactory upper limit for the Bay Area.

The alternate level of fertility, on the other hand, allows for a steeper decline during the first 20 years of the projection period, with the level remaining constant thereafter. The implied GRR of 1.28 is still above the "depression levels" of the 1930's but remains substantially below the recent, higher post-World War II levels. Under the assumptions of high employment and sustained high levels of economic activity, it was deemed inadvisable here to assume future fertility levels as low as those prevailing during the mid-1930's, even as a lower limit.

(3) *Mortality.*—In relation to fertility and migration, mortality plays a somewhat minor role in population projections, and estimates of future number of deaths can be developed with considerably more certainty than projections of births and net migration. National mortality levels are generally satisfactory guides for determining the number of deaths in a specific geographic area. The projected national mortality levels available for use here were based on "high" and "low" assumptions concerning the outlook for reduction in mortality for various broad groups of causes of death. In general, the "low mortality" projection is intended to reflect a definitely optimistic view as to the future cause of mortality, while the "high mortality" projection is intended to reflect a pessimistic view, particularly with regard to the possibility of reduction in death rates for the diseases typical of old age. Even the high-mortality projection, however, does contemplate some future improvement in the mortality rate. The rates used for this study represent a position "medium" to these high and low rates, and they allow for continuing moderate improvements in mortality rate to the end of this century.

B–4. RATIO TECHNIQUE

The ratio technique used to develop the projections for the years 1980 to 2010, like other methods of population projections, presumes that past trends in population provide a convenient key to estimating future growth or decline. On the average, it would appear that trends (estimated or projected) in the period immediately prior to the initial projection date (in this instance, 1970) would be of greater value for projection purposes than trends in the more remote past, thereby assuring smooth transition from the recent past to the immediate future. The base period chosen here for determining rates of change in the ratios—the 1956–70 period—had the further advantage of yielding, in general, lower average annual rates of change than earlier periods. In recognition of the fact that the record of the past is only a partial guide to the future, steps were taken to scale down the rate of change in the ratio observed in the base period by presuming that the change in ratios would cease at a point 50 years beyond the benchmark date. As applied here, then, the ratio method tends to be conservative in that it permits further changes in the proportion of population in specific areas, and it presumes a slowing down of the process of population redistribution within the Bay Area.

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[3] The GRR is used as a summary measure of annual fertility. It indicates the number of daughters a group of newborn female infants would have during their lifetimes if the group were subject to the given set of age-specific birth rates and none of the infants died before reaching the end of the child-bearing ages. A rate of 1.00 would represent exact replacement in the next generation.

Appendix C. Manufacturing Diversification Index

C-1. PURPOSE

This section explains the method used to develop the diversification index and compare the San Francisco-Oakland manufacturing economy with economies of selected other large metropolitan areas.

C-2. MANUFACTURING DIVERSIFICATION INDEX

The manufacturing diversification index is based on the assumption that the distribution of manufactures by industry types (142 Standard Industrial Classes used in the U.S. Census of Manufactures) for the United States as a whole represents full diversification. The percentage distribution for a specific area (Standard Metropolitan Area) is computed and compared to the composition of industry in the United States as a whole. If a Standard Metropolitan Area (SMA) were to contain all the industry classes present in the United States and in the same proportion as measured by employment, then it would have an industrial diversification index of 100. The deviations for any SMA are measured and then given values. The sum of these values is subtracted from 100—the assumed "full diversification" value of the United States as a whole—and the difference gives the diversification index for that SMA.

Diversification of manufacturing industries can be illustrated in still another way. By 1954, the San Francisco-Oakland SMA had some employment in 131 of the 142 Standard Industrial Classification (SIC)[1] three-digit industry-group categories, the New York-Northeast New Jersey SMA had employment in 139 categories, Los Angeles and Chicago had 134 each, and Philadelphia had 133. The other large manufacturing centers had less than 131 categories represented, or fewer than San Francisco-Oakland. (See table C–1.)

The noteworthiness of this high rank for San Francisco-Oakland is that it has been achieved with a relatively small manufacturing employment force. In 1954, San Francisco-Oakland, with 173,000 manufacturing employees, ranked 12th in the United States, far behind such giant manufacturing centers as New York, Chicago, Philadelphia, and Los Angeles. (See table C–1.)

This point is even more dramatic if expressed in relation to the number of industry categories present in the metropolitan areas. As shown in table C–1, the number of manufacturing employees per three-digit SIC industry group present is much lower for San Francisco-Oakland than it is for any other large SMA except Cincinnati. In effect, New York-Northeastern New Jersey had only 8 more SIC categories of employment, but it had 10 times more manufacturing employees than did San Francisco-Oakland; and Los Angeles, with 3½ times the number of manufacturing employees, had only five more classes of industry than San Francisco-Oakland had in 1954.

A high diversification index together with a large number of categories of industry constitute a further reason for visualizing a promising future in the manufacturing field for the San Francisco Bay Area. It means that the Bay Area presumably has the proper combination of conditions needed to meet the locational requirements of a wide variety of manufacturing operations. With a well-diversified industrial base and a large variety of manufacturing establishments already present in the San Francisco Bay Area, it is apparent that the bulk of future growth of manufacturing is most likely to occur in those industries that are now represented in the economy.

It seems reasonable to conclude also that among industries already represented in the SMA, the outlook for expansion is about as good for industries that are not now well developed as it is for those that are well developed. To help illustrate this point, table C–2 lists the forty 3-digit industry-group categories that comprise the two ends of the local manufacturing industry spectrum—20 that are relatively better developed in terms of employment than they are in the country as a whole, and the 20 industries that were present but least well developed with respect to employment percentage for the country as a whole.

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[1] In the parlance of the Standard Industrial Classification system, the terms "two-digit," "three-digit," and "four-digit" are used to indicate level of detail: thus, Major Group No. 20, "Food and kindred products," is at the two-digit level; Industry Group No. 201, "Meat products," is at the three-digit level; and Industry No. 2015, "Poultry dressing plants," is at the four-digit level of detail.

Table C–1.—Diversification Characteristics of Manufacturing Industry in 13 Major Manufacturing Standard Metropolitan Areas: 1954[1]

Standard Metropolitan Areas	Diversification		Number of SIC[2] industry groups (3-digit) represented	Population[3]	Manufacturing employees	Percent of population in manufacturing
	Index	Rank				
				Thousands	*Thousands*	
Philadelphia	71.3	1	135	3,909	547	14.0
St. Louis	68.7	2	128	1,795	251	14.0
San Francisco-Oakland	66.8	3	131	2,493	173	6.9
Chicago	66.3	4	136	5,760	946	16.4
Los Angeles-Long Beach	66.1	5	136	4,990	639	12.8
New York-Northeastern New Jersey	65.9	6	139	13,680	1,732	12.7
Cincinnati	65.7	7	121	942	151	16.0
Baltimore	62.9	8	121	1,445	188	13.0
Cleveland	61.8	9	125	1,534	291	19.0
Boston	61.1	10	130	2,968	280	9.4
Buffalo	59.2	18	134	1,555	200	12.9
Detroit	47.7	26	125	3,336	538	16.1
Pittsburgh	46.5	32	119	2,249	303	13.5

[1] SMA's with more than 150,000 manufacturing employees in 1954.

[2] SIC—Standard Industrial Classification.

[3] 1954 estimate, Sales Management magazine.

In the left-hand column of table C–2 are listed the 20 categories of manufactures in each of which the percent of employment for the San Francisco-Oakland SMA was in greatest excess over the percent of employment in the same category for the United States as a whole. In each case, the plus deviation was more than one-tenth (0.1) of 1 percentage point but less than 5 percentage points greater than the corresponding national percentage.

Similarly, the categories in the right-hand column of table C–2 are the 20 categories in which the San Francisco-Oakland SMA was most deficient in employment in 1954. One of these categories (223 Broadwoven fabrics, except wool) had no reported employment. For the others, the percentage of local employment was from 0.1 to 5 percentage points less than the corresponding percentage for the United States as a whole.

As is indicated by the decade-by-decade employment projections in table 21, chapter III, chemicals, paper products, and electrical and nonelectrical machinery are among the major industry groups expected to expand in future decades at rates well above the rate for manufacturing as a whole. Each of these major groups is well represented by the well-developed and the poorly developed industry groups listed in table C–2.

Among the eleven three-digit industry groups not represented in the San Francisco-Oakland SMA economy in 1954, the majority cannot be considered as strong candidates for the Bay Area economy in the future. Table C–3 lists these 11 industry groups and indicates whether they were present in the manufacturing complexes of the Nation's 4 largest industrial metropolitan areas—New York-Northeastern New Jersey, Chicago, Los Angeles, and Philadelphia. The majority are examples either of resource-oriented industries whose geographic distributions exhibit a high degree of regional localization (i.e., textiles, coke, footwear), or of industries characteristically not found in the largest metropolitan areas (i.e., flat glass, and tobacco).

Table C-2.—SIC 3-Digit Manufacturing Industry Groups with Greatest Plus and Minus Deviations of Industrial Diversification from National Average, San Francisco-Oakland Standard Metropolitan Area: 1954 [1]

Plus Deviations
(Best developed)

203	Canning, processing, and freezing.
205	Bakery products.
206	Sugar.
207	Confectionery and related food.
208	Beverages.
209	Miscellaneous food products.
267	Paperboard containers and boxes.
271	Newspapers.
275	Commercial printing.
276	Lithographing.
281	Industrial inorganic chemicals.
285	Paint and allied products.
289	Miscellaneous chemical products.
291	Petroleum refining.
322	Pressed and blown glassware.
341	Tin cans and other tinware.
343	Heating and plumbing equipment.
344	Structural metal products.
357	Office and store machinery.
373	Ships and boats.

Minus Deviations
(Least developed)

221	Woolen and worsted manufacturers.
222	Yarn and thread mills, except wool.
223	Broadwoven fabrics, except wool.
225	Knitting mills.
231	Men's and boys' suits and coats.
232	Men's and boys' furnishings.
234	Women's and children's undergarments.
242	Lumber—basic timber products.
261	Pulp, paper, and paperboard.
282	Industrial organic chemicals.
314	Footwear, except rubber.
335	Nonferrous rolling and drawing.
346	Metal stamping and coating.
352	Tractors and farm machinery.
354	Metalworking machinery.
358	Service and household machines.
361	Electrical industrial apparatus.
371	Motor vehicles and equipment.
372	Aircraft and parts.
398–99	Miscellaneous manufactures.

[1] Data are from unpublished U.S. Bureau of the Census tabulations. Actual deviations are omitted to avoid disclosure.

Table C-3.—SIC Categories of Manufacturing Not Present in 5 Selected SMA's in 1954 [1]

SIC Industry-group category	San Francisco-Oakland	Philadelphia	Los Angeles	Chicago	New York-Northeastern New Jersey
213 Chewing and smoking tobacco	A		A		
214 Tobacco stemming and redrying	A	A	A	A	
223 Broadwoven fabrics	A				
224 Narrow fabric mills	A				
293 Coke and byproducts	A		A		
302 Rubber footwear	A	A		A	
303 Reclaimed rubber	A			A	
313 Footwear, cut stock	A				
321 Flat glass	A	A		A	A
364 Engine electrical equipment	A				
374 Railroad equipment	A		A		

[1] Data are limited to the 5 SMA's with the largest representation of SIC categories because, in view of the large growth that has been predicted, it is unlikely that in the future San Francisco-Oakland will have fewer industry-group categories than it had in 1954.

A—Absent.

Appendix D. Methods Used in Land-use Study

D-1. INTRODUCTION TO MAP AND STATISTICAL METHODS

The land-use study provided a check on the sufficiency of land in the San Francisco Bay Area of adequate quality and characteristics necessary to support the population and economic development projected for the Bay Area; it also pinpointed the expected pattern of urban-land expansion. The land-use projection, by period, also provided the framework within which the estimated township populations, arrived at by the Area Density Method (see app. A), could be distributed geographically within the townships.

Two alternate, complementary methods were used to estimate the amount of land that would be required in various land-use categories over the 60-year projection period. One, a map method (see below), involved the mapping, by 10-year periods, of an orderly, related, and controlled extension of past and present land uses. The series of land-use maps accompanying this report was a major product of this approach. (See pls. 11–18, plate supplement.)

The complementary method used a statistical conversion of estimates of population and work force to arrive at estimates of the amount of land required for industrial, commercial, and residential uses. (See pp. D–4—D–7.) Both methods make the same assumptions on the growth in the local economy over the study period, but they are sufficiently different in technique so as to provide reasonable cross-checks on the results of each.

The statistical method is adequate for quickly estimating total land requirements, given a satisfactory conversion table, but it is impractical for locating expected industrial growth within smaller areas. The map method is expensive in time and necessary fieldwork, but it is much more specific on expectations of land needs in small areas where local physiographic or historical conditions may be dominant in projecting land use. Employed jointly, the two methods provide a reliable estimate of the urban growth possibilities within local geographic and economic limits.

D-2. MAP METHOD

For each consecutive 10-year period of the study, a map was prepared to show the probable location and extent of six major land-use classes. (See below.) Plate 11, "Land Use—1958" (see plate supplement), which was used as the platform for projection of future land use, represents the land situation in the San Francisco Bay Area in 1958—the start of the study period. The base map used was a land-use map, scale 8 miles to the inch, compiled in 1954 for the Rapid Transit Survey covering the San Francisco Bay Area (171). This map was brought up to date with information collected from a variety of sources. The information came from maps supplied by the planning commissions of the larger cities and of the nine county jurisdictions, and from other sources including field observation and interviews. Reliability of the data varied by county. Generally, information from the southern counties was of more recent date, although information in the northern counties to 1954 was available.

(*a*) *Land-use classes.*—The land-classification system used in the study and for the sequence maps is based on earlier studies of the Bay Area. The land-use types are recognizable in all of the planning studies used in compilation of the base and were manageable for cartographic compilation and presentation. Since the map showing land use in 1958 would be used for projecting land use into the future, a simplified system of major use categories was essential. Therefore, uses which are normally associated in areas over long periods of time were grouped together. Finer, detailed distinctions in types of use were generalized into broad categories in keeping with the detail of the economic data that were being developed independently and which would serve as a check against the land-use projections.

The residential-commercial land-use category points up the method used. This class includes all land use associated with housing of individuals and with the consumer servicing of these residents. In addition to residences, it includes commercial centers, strip commercial development, small city parks and semipublic lands in urban areas, and cemeteries and other uses directly related to population. Other broad use types were similarly combined.

The six generalized categories of land use are described below:

(1) *Residential and commercial land.*—Comprises land used in usual urban and suburban living and includes areas of three or more dwelling units per acre (for example, hotels, apartments, row houses, and closely spaced single dwellings), local parks, amusement areas, retail establishments, and offices.

(2) *Industrial land.*—Comprises land which provides employment other than local services and includes major areas devoted to transportation, quarries and gravel pits, tank farms, warehouses, factories, and land which is owned and held in reserve for industrial expansion.

(3) *Salt ponds.*—Comprise, essentially, salt evaporators developed on reclaimed marsh or tide lands (considered separately because further development

generally would be necessary before this land could be put to other use).

(4) *Public and reserved land.*—Comprises large units of land held for special public services and includes military and naval installations, public parks, game refuges, watershed and reservoir lands, and other lands held by Federal, State, or local agencies.

(5) *Agricultural land.*—Comprises land used for any kind of agriculture and includes grazing land, grain and hay fields, fallow land, vineyards, orchards, truck gardens, and land devoted to ornamental horticulture.

(6) *Undeveloped, unused or waste land.*—Comprises land which is not reserved or otherwise used and includes forest, scrub, moor, and marsh.

(*b*) *Projecting future uses.*—Compilation of the land-use map for 1960 followed completion of the map of uses existing in 1958. The outline of the land suitable for urban development (see pl. 10, plate supplement) was transferred to the base map. Urban development, as projected by the study, would necessarily be located within this line of generalized maximum urban growth. In many areas, particularly in the North Bay, urban land use would not approach the urban limit by the end of the study period, 2020. In other areas, especially in restricted transportation corridors such as narrow valleys, the outward limit might be reached within a short time.

Changes in the public- and reserved-land categories were made next. These projected changes to 1960 were minor and included only announced and immediate changes in the 1958 map. No major expansions or contractions in reserved lands were expected during this 2-year period. Similarly, only minuscule changes were made in the salt ponds.

Industrial land use and residential and commercial land use were considered as part of the same urban growth phenomenon. The allocation of land for these purposes was made for the period by applying certain simple, assumed rates of growth and adding that growth to the pattern of the previous period. (See fig. D–1.)

Determination of these approximate rates was made on the basis of county planning commission studies and maps showing past and current land use. Information was not complete for all counties. Measurements were made of the maximum displacement of land-use boundaries along major transportation routes over the period of the available data. From these measurements, and from measures of minimal expansion of the same land-use areas, an average annual figure was derived for outward expansion of the land-use areas of the 1958 land-use categories. The rate varied from county to county and frequently within counties.

(1) *Industrial areas.*—New industrial land was located along or between transportation routes and in some cases in industrial parks where location on large tracts was feasible.

Most projected industrial-land requirements were located on land of adequate bearing capacity with slopes of 5 percent or less. (See pl. 10, plate supplement.) In most cases, this land is less desirable for residential uses because of location. New industrial uses usually abut on older industrial land.

For the first three projection intervals—1960, 1970, and 1980—an approximate trial proof was used to test the mapped land-use projections against preliminary population projections for the Bay Area (76, table 4—High Projections).

The total area devoted to industrial land was measured by scale to the nearest hundredth of a square mile. Using an assumed general employee-density figure ranging from 3½ employees per acre in the northern counties to 4½ and 5 employees per acre in the southern counties, there was obtained a total approximate employment figure for the Bay Area which provided a continuous running check, as the maps were compiled, against the total population. (See table D–1.) Manufacturing employment was assumed to be approximately 20 percent of total employment, which, in turn, was assumed to be about 40 percent of the total population. The resulting justifications were adequate, and it was decided to continue the map projections for the latter 10-year periods.

This preliminary check was used only in the periods to 1980. Subsequently, the reasonableness of the industrial-land projection for the whole projection period was checked against the preliminary population projections recommended for the Bay Area (76, table 4—High Projections).

Table D–1.—Comparison of Derived and Estimated Population Using Industrial Land: San Francisco Bay Area

Decade	Population derived from map and manufacturing densities	Estimated population[1]
1960	3, 687, 000	3, 691, 000
1970	4, 987, 000	4, 788, 000
1980	6, 699, 000	5, 890, 000

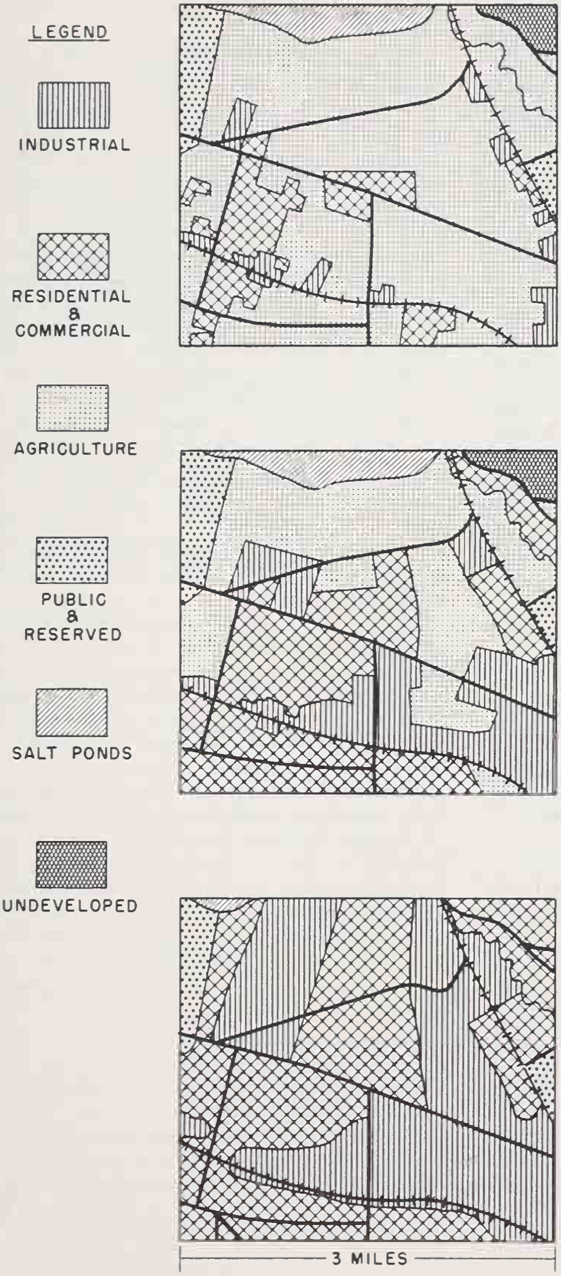
[1] "Economic Aspects of Survey for the Comprehensive Development of San Francisco Bay and Tributaries, Part I: Evaluation of Existing Population Projections;" Office of Area Development, U.S. Department of Commerce, Washington, D.C., October 1957, p. 16, Table 4, High Projections.

(2) *Residential areas.*—Major highways provided the skeleton for extension of present residential and commercial uses. However, two types of development were presumed: strip-type development along roads and highways, and scatter-type development where topographic conditions and transportation permitted. Strip development would continue in areas where it existed in the past, and scatter or tract development would be projected where sites were available and adequate. Scatter-type development requires extensive, level land where a simple street network can be easily provided. Large tract developments also would be expected near important highway intersections and near previously built-up areas with established public utilities which can be extended readily.

CORPS OF ENGINEERS U.S. ARMY

FIGURE D·1

ILLUSTRATIVE LAND USE



1958

ACTUAL CURRENT LAND USE. AGRICULTURAL USE OF LEVEL LAND. CONCENTRATION OF RESIDENTIAL AND SCATTERED INDUSTRIAL USES AT INTERSECTIONS AND TRANSPORTATION CROSSINGS. A FEW LARGE DISPERSED INDUSTRIAL SITES.

1990

EXTENSION OF RESIDENTIAL AND INDUSTRIAL USES ONTO LEVEL FARMLAND WITH CONCENTRATIONS ALONG HIGHWAYS AND RAILROADS, PARTICULARLY AT INTERSECTIONS. PERSISTENCE OF RESERVED LANDS AND SALT PONDS. EXPANSION CONSISTENT WITH EXPECTED GROWTH RATES.

2020

DISAPPEARANCE OF AGRICULTURE. FURTHER EXTENSIONS OF INDUSTRIAL USE INCLUDING RECLAMATION OF ADJACENT TIDAL AREAS. GENERAL FILLING IN OF INTENSIVE USES. CONTINUED PERSISTENCE OF RESERVED LANDS. SALT PONDS HAVE ALMOST DISAPPEARED.

COMPREHENSIVE SURVEY OF
SAN FRANCISCO BAY AND TRIBUTARIES

ILLUSTRATIVE LAND USE

OFFICE OF AREA DEVELOPMENT
U.S. DEPARTMENT OF COMMERCE
WASHINGTON, D.C.
DRAWN: JRF FILE NO.
TRACED: JRF TO ACCOMPANY REPORT
CHECKED: JW · DATED: Dec. 1959

The scatter or tract development shown on the maps of future land use is not intended to show the exact location of a residential subdivision. It is intended to convey the proposition that, within the general local area, scattered homes or subdivisions of several houses or several hundred houses will be developed. It may indicate also that, on the basis of local physiography, these areas are more suitable for residential development than are other areas or that these areas are less suitable for other uses such as industrial development.

The reasonableness of the residential area projections for the first three decades were checked also against the preliminary population estimates of the Bay Area, using a trial method similar to that used for the check on industrial land. A density of 12,500 persons per square mile was used for older, built-up sections. The areas of these sections were estimated as a proportion of the mapped residential-commercial category. A density of 5,000 persons per square mile was used for the suburban residential areas. In the North Bay counties, however, a density of 5,000 was used for all residential land. No density was assumed for agricultural land, the assumption being that population would be included but obscured in the total area density. These densities were derived in a spot check of population densities using the Bay Area transit survey land-use study of 1954 (171) and population estimates of the State of California Department of Finance. Population data derived by this method checked closely with the preliminary population estimates for the Bay Area. (See table D–2.)

Table D–2.—Comparison of Derived and Estimated Population Using Residential Land: San Francisco Bay Area

Decade	Population derived from map and population densities	Estimated population [1]
1960	3, 690, 000	3, 691, 000
1970	4, 680, 000	4, 788, 000
1980	6, 030, 000	5, 890, 000

[1] "Economic Aspects of Survey for the Comprehensive Development of San Francisco Bay and Tributaries, Part I: Evaluation of Existing Population Projections;" Office of Area Development, U.S. Department of Commerce, Washington, D.C., October 1957, p. 16, Table 4, High Projections.

Projecting land use by the map technique provides a reasonable method for geographically allocating regional totals over smaller political and physiographic subdivisions. Each land-use map represents the best total estimate of timing of regional growth on the physical platform of the study area. The reasonableness of these map estimates of growth can be checked against the framework provided by other projection techniques.

D–3. STATISTICAL METHOD

The reasonableness of the estimates of projected industrial-land requirements derived by direct area measurement on the land-use maps was checked by comparing them with estimates derived by statistical methods. The statistical methods were based on the anticipated industrial employment projected as part of the economic section of the study. (See ch. III, table 21.) An industrial land-use density factor was applied to industrial employment to arrive at periodic industrial-land increments over the period of this study.

Given a projected population and/or employment by industry, it is possible to derive total acreage requirements by industry if the amount of land used by each employee—the land-requirement factor—is known or can be estimated. No land-requirement-factor table has been thoroughly worked out for the San Francisco Bay Area. The San Francisco Planning Commission developed factors for the city; other local planning commissions have explored the problem in general terms. It was not possible with the resources available for the present study to make the detailed local census needed to develop a unique conversion table for the entire Bay Area.

Studies on the ratio of industrial land per employee, preferably by industry, have been made for several large cities and at least one metropolitan area since World War II. Detroit, Chicago, Cincinnati, Indianapolis, Tulsa, Philadelphia, and others have been studied primarily by planners concerned with the future space requirements of local industry. The methods and the industrial densities used in these studies have varied in detail and applicability, although all the studies reached essentially the same general conclusion: a definite, determinable relationship exists between type of industry and land requirements for that industry. The need for further comparative research on this problem is apparent from the variations in land ratios encountered in the several studies.

Employee-acreage ratios, by industry, were derived for the Bay Area by adapting the research techniques recently developed by the Institute for Urban Studies of the University of Pennsylvania for the Pennsylvania Department of Commerce in studying the four counties of the Philadelphia urban region (197). Employment data for two-digit SIC categories for the Bay Area in 1958 were provided by the California Department of Finance. Industrial densities from the Philadelphia study were used for all two-digit SIC categories applicable to the San Francisco Bay Area. (See table D–3.)

Table D–3.—Ratios of Industrial Land to Employment for Use in Projecting Future Industrial Land Needs

Industry land-use group	Type of major industry group and SIC code	Acres per 1,000 employees
I	Intensive	30
	23 Apparel and related products.	
	36 Electrical machinery.	
	38 Instruments and related products.	
II	Intermediate-intensive	40
	27 Printing and publishing.	
	37 Transportation equipment.	
III	Intermediate-extensive	90
	20 Food and kindred products.	
	24 Lumber and wood products.	
	25 Furniture and fixtures.	
	26 Pulp, paper, and products.	
	28 Chemicals and products.	
	30 Rubber products.	
	33 Primary metal industries.	
	34 Fabricated metal products.	
	35 Machinery, except electrical.	
	39 Miscellaneous manufactures.	
IV	Extensive	375
	29 Petroleum and coal products.	
	31 Leather and leather goods.	
	32 Stone, clay, and glass products.	
	All industry	125
	Public utilities [1]	200

[1] Not included in method of Institute for Urban Studies, University of Pennsylvania.

Source: See app. E, Bibliography (197).

The average figure for all industry used in the Philadelphia study, 125 acres per 1,000 employees, was used as a factor for those two-digit major industry groups in San Francisco which were not analyzed or used in the Philadelphia study. Since transportation and public utilities were included in the industrial category in the San Francisco Bay Area land-use maps, for these facilities a factor of 200 acres per 1,000 employees was used. This is one-half the density of the San Francisco and Oakland Airports, the largest single land use in this category, but 60 percent greater than the average for all industry.

The total industrial acreage derived from the 1958 employment (by industry groups) and the above densities totaled 87 square miles. The total acreage of industrial use depicted on the map "Land Use—1958" (see pl. 11, plate supplement) was 80 square miles. The similarity of the statistically derived figure and the total acreage derived from the field map (see table D–6) was assumed to be adequate justification for the use of the Philadelphia industrial land-use factors. Other considerations were the apparent similarity between the economies of the two ports, the cities, and their hinterlands. These similarities were confirmed by examination of several recent statistical comparisons of metropolitan regions, including unpublished research on industrial diversification of urban centers in the files of the Office of Area Development. (See ch. III, p. 50.)

The Philadelphia study also suggested a method for making estimates of industrial land for future periods. This method, modified and extended, was used to derive estimates of future requirements for industrial land in the Bay Area over the projection period. (See table D–5.) In constructing table D–5, the increment of new employment obtained from the employment projections (see table 21, ch. III) was provided for each industrial land-use group. This employment was multiplied by the existing acreage requirement per 1,000 employees, as was done in the Philadelphia study. (See table D–3.) In addition, there was introduced a factor to provide for expected future increased land requirements per worker. (See table D–4.) The total increment for the projected period was added to the present industrial land to give total expected industrial land in 2020.

Table D–4.—Percentage Increase in Industrial Land Requirements Per Worker by Period, from Base Year (1958)

Period	*Percentage Increase*
1958–60	2.0
1970	9.0
1980	9.0
1990	8.5
2000	7.5
2010	6.0
2020	4.5

In the Philadelphia study, the estimates of future land were increased by 25 percent for the 24-year period from 1956 to 1980 to cover an anticipated increase in land requirements per new worker due to such factors as greater mechanization, dispersal, and increasing parking and service area needs. A comparable increase was used in the present study for the 2-year period 1958–60, and again for the two decades 1960–70 and 1970–80.

This increase is slightly less than 1 percent per year—less than 10 percent per decade—and avoids the compound interest effect as suggested in the Philadelphia study. The estimates of both studies probably are conservative.

Table D-5.—Industrial Land Requirements for San Francisco Bay Area: 1958-2020 [1]

	Industry land-use group				All other	Transportation, communications, and public utilities	Total	
	I [2]	II [2]	III [2]	IV [2]			Acres	Square Miles
1958 total industrial land								87. 3
1958-60:								
Increment of new employment	3, 200	9, 800	26, 000	5, 700	2, 100	8, 900		
Acreage per 1,000 new workers	30	40	90	375	125	200		
New acreage at old rate	96	392	2, 340	2, 138	263	1, 780		
Allowance for increased land requirements per worker—2 percent	2	8	47	43	5	36		
Total new acreage	98	400	2, 387	2, 181	268	1, 816	7, 150	
Equivalent in square miles	0. 2	0. 6	3. 7	3. 4	0. 4	2. 8		11. 2
Total new industrial land								98. 5
1960-70:								
Increment of new employment	18, 400	14, 000	75, 400	5, 800	12, 500	23, 000		
Acreage per 1,000 new workers	30	40	90	375	125	200		
New acreage at old rate	552	560	6, 786	2, 175	1, 563	4, 600		
Allowance for increased land requirements per worker—9 percent	50	50	611	196	141	414		
Total new acreage	602	610	7, 397	2, 371	1, 704	5, 014	17, 698	
Equivalent in square miles	0. 9	1. 0	11. 6	3. 7	2. 7	7. 8		27. 7
Total new industrial land								126. 2
1970-80:								
Increment of new employment	25, 200	15, 300	94, 400	8, 200	12, 500	41, 000		
Acreage per 1,000 new workers	30	40	90	375	125	200		
New acreage at old rate	756	612	8, 496	3, 075	1, 563	8, 200		
Allowance for increased land requirements per worker—9 percent	68	55	765	277	141	738		
Total new acreage	824	667	9, 261	3. 352	1, 704	8, 938	24, 746	
Equivalent in square miles	1. 3	1. 0	14. 5	5. 2	2. 7	14. 0		38. 7
Total new industrial land								164. 9
1980-90:								
Increment of new employment	36, 400	18, 500	97, 500	13, 200	12, 600	35, 000		
Acreage per 1,000 new workers	30	40	90	375	125	200		
New acreage at old rate	1, 092	740	8, 775	4, 950	1, 575	7, 000		
Allowance for increased land requirements per worker—8½ percent	93	63	746	421	134	595		
Total new acreage	1, 185	803	9, 521	5, 371	1, 709	7, 595	26, 184	
Equivalent in square miles	1. 9	1. 3	14. 9	8. 4	2. 7	11. 9		40. 9
Total new industrial land								205. 8
1990-2000:								
Increment of new employment	19, 600	5, 700	42, 700	3, 700	3, 300	32, 000		
Acreage per 1,000 new workers	30	40	90	375	125	200		
New acreage at old rate	588	228	3, 843	1, 388	413	6, 400		
Allowance for increased land requirements per worker—7½ percent	44	17	288	104	31	480		
Total new acreage	632	245	4, 131	1, 492	444	6, 880	13, 824	
Equivalent in square miles	1. 0	0. 4	6. 5	2. 3	0. 7	10. 8		21. 6
Total new industrial land								227. 4
2000-10:								
Increment of new employment	43, 900	20, 400	122, 300	13, 800	16, 600	83, 000		
Acreage per 1,000 new workers	30	40	90	375	125	200		
New acreage at old rate	1, 317	816	11, 007	5, 175	2, 075	16, 600		
Allowance for increased land requirements per worker—6 percent	79	49	660	311	125	996		
Total new acreage	1, 396	865	11, 667	5, 486	2, 200	17, 596	39, 210	
Equivalent in square miles	2. 2	1. 4	18. 2	8. 6	3. 4	27. 5		61. 3
Total new industrial land								288. 7
2010-20:								
Increment of new employment	43, 900	20, 900	122, 100	11, 900	13, 100	79, 000		
Acreage per 1,000 new workers	30	40	90	375	125	200		
New acreage at old rate	1, 317	836	10, 989	4, 463	1, 638	15, 800		
Allowance for increased land requirements per worker—4½ percent	59	38	495	201	74	711		
Total new acreage	1, 376	874	11, 484	4, 664	1, 712	16, 511	36, 621	
Equivalent in square miles	2. 2	1. 4	17. 9	7. 3	2. 7	25. 8		57. 2
Total new industrial land								345. 9

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[1] Statistically derived from projected employment.

[2] See table D-3.

Beyond 1980, it was decided to maintain an increase in land per worker for the increment of new workers, but at a gradually reduced rate as the amount of urban land in use begins to approach the physical limits of land suitable for large plants in the Bay Area. It was assumed that, even before 2020, manufacturers sensitive to competition for land would begin to seek sites for expansion beyond the boundaries of the nine counties of the study area. The percentage increases in industrial-land increments for each period (see table D–4) were introduced in table D–5 to allow for increased industrial-land requirements per worker during each period from 1958 to 2020.

It was anticipated that the match between the map and statistical methods would not be exact, and a margin of error of up to 15 percent seemed acceptable because of the length of the projection period, uncertainties on the ratios used in the statistical method, and the multiplicity and complexity of land-use factors considered in making the map projections. (See table D–6.)

Table D–6.—Industrial Land Requirements, San Francisco Bay Area: 1958–2020

(Comparison of Map and Statistical Methods for Projecting Land Use)

[Square miles]

Period	As measured on map	As derived statistically
1958	80	87
1958 to 1960	98	99
1960 to 1970	124	126
1970 to 1980	154	165
1980 to 1990	183	206
1990 to 2000	220	227
2000 to 2010	254	289
2010 to 2020	310	346

The results of the comparison give assurance that the methods used for projecting land use were consistent over the period of the study and that the maps reflect reasonably the anticipated amount and direction of growth in the Bay Area.

D–4. METHOD FOR DETERMINING AREAS SUITABLE FOR URBAN PURPOSES

Standards for selection of land suitable for future urban development vary according to the use being planned and to the criteria of selection. The gross quality requirements necessary to the San Francisco Bay Area projection were general rather than specific and limited to physiographic considerations. The principal objective criteria used were the relative regularity of direction of contour lines and the relative distance between contour intervals on large-scale topographic maps. Greatest accuracy was obtained in the flat valleys and coastal areas.

Topographic maps covering the complete nine-county Bay Area were not available on a single scale. The areas of flat and gently sloping lands were indicated on these maps by inspection and measured with a grid system. Maps used were U.S.G.S. 15- and 7½-minute quadrangles at RF 1:31,680 and 1:24,000; and Army Map Service (AMS) Series V 602 at RF 1:100,000 and AMS Series V 795 at RF 1:50,000. Contour intervals for the maps of different scale varied from 5 to 100 feet.

It was assumed that slope of land would be the most important, if not the critical, characteristic, in estimating probable future urban land use. Since 30-percent slope was used in the Bay Area transit survey (30) as a critical limit on urban construction, this limit was used in the present study. The method was checked with a more detailed study of Santa Clara County, and results of the two methods were found to be essentially the same. The detailed steps in the Santa Clara study are described below.

From the topographic map, square-mile sections were selected by inspection for detailed spot checks to determine what could be considered the steepest slopes in the county. Four sections were selected, two of which, by map symbols, indicated urban-type development, and two of which showed no culture symbols. These four sections appeared to have the highest density of contours and great irregularity in direction, indicating rugged topography. The average slope of each section was calculated by taking the average of four cross-section counts of the contours. The range in average slope among the four sections was from 23 to 28 percent. The most heavily built-up section showed an average slope of 28 percent.

The same four sections were checked also for the difference between the highest and lowest elevations. The range in relief was from 380 to 800 feet. The heavily built-up sections showed relative relief of 400 and 620 feet. This indicated that relief, in itself, would not be a critical consideration in residential development of large sections of the Bay Area.

The Santa Clara land area to be measured was delimited on the maps by tracing the contour which delimited the break in slope from the valley floor to the mountain area. The area delimited in this manner did not follow any single contour, but moved from higher to lower or reverse as general elevation increased or decreased, without an abrupt change in slope. After the areas of flat and gently sloping land had been delimited, a transparent grid was constructed to square-mile and 10-acre scale, and the area was computed to approximate totals. Since some development will occur on the rougher, steeper lands, these measurements should be considered solely as the minimum amount of land that is physically suited to urban-type development.

The State of California, in its 1955 barrier feasibility study (8, app. A, table 12), estimated the ultimate urban area of Santa Clara County to be about 354 square miles, compared to the total of 450 square miles as measured in the present study. The large variance may be due in part to the subjective difference in criteria employed in delimiting the area to be measured. The State study selected the 500-foot contour as the mean elevation of the limit of urban development. The delimitation used here includes some sizable side valleys with gentle, longitudinal slope, but at elevations above 500 feet.

The measurements of land-use types or of land suitable for urban development made in this study are not intended to be absolute; they do, however—within the limits imposed by the source material—represent a rough yardstick of the land area that may be in demand for urban use at different periods of time in the future. They indicate also the relative degree of development possible under differing assumed conditions of economic and population growth.

D–5. MEASUREMENT OF LAND-USE MAPS

No precise measurements of land area by type use were available in preparing this report. The planimeter measurements of land-use categories over the period of study were made on the land-use maps. (See pls. 11–18, plate supplement.) A minimum of two readings of each use parcel was made to assure greater accuracy. Smaller and regular-shaped units were also measured and checked with a scale. Fractional totals were rounded to whole numbers.

Three categories of land use—industrial land, residential and commercial land, and agricultural land—were measured, by counties, for each of the 8 years represented in the land-use maps. All categories of land use (the above three plus salt ponds, public and reserved land, and undeveloped or unused lands) were measured for the years 1958 and 1960 as a test of the measuring techniques. The combined total of all land area planimetered for all uses was checked against the total of all land area as reported by the U.S. Bureau of the Census. The error of measurement between the figure arrived at by Office of Area Development planimetering and the area total published by the Bureau of the Census was about 1½ percent. The planimeter totals for these years were subsequently adjusted to the Bureau of the Census totals for statistical use in the survey.

The total square mileage for the remaining decades in the category "Other Land Use," which includes salt ponds, public and reserved land, and undeveloped or unused lands, was determined by subtracting the three measured categories of land use (industrial, residential and commercial, and agricultural) from the county land-area totals as obtained from the Bureau of the Census and adjusted by the Office of Area Development.

As reported by the Bureau of the Census in 1940, the total land area of the nine San Francisco Bay Area counties was 6,988 square miles. This figure has subsequently been reduced by the recent creation of Lake Berryessa in Napa County. The basis of its exclusion from the land area total is the definition of land area as established by the Bureau of the Census. Areas of reservoirs of more than 40 acres are not included in Census land-area totals. An area of 30 square miles was determined by planimeter readings for Lake Berryessa, thereby reducing the total land area of the nine counties to 6,958 square miles. The corrected total for the Bay Area counties was used for the years 1958 and 1960; thereafter, however, it was gradually increased to the year 2020 to include reclamation of an estimated 18 square miles of tide and submerged lands not included in present Census area totals. (See ch. V, p. 93.)

Appendix E. Selected Bibliography and Reclamation Bibliography

E–1. INTRODUCTION TO SELECTED BIBLIOGRAPHY

The source-reference groupings which follow are not mutually exclusive. There is an overlapping of subject matter within a number of cited items, but these items have been listed under headings considered most pertinent to their use in preparation of this report.

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The literature was searched largely for material published during the period 1930–57, but some important earlier references also were included.

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(2) The most logical and economic method of increasing park and boulevard areas nearest the highly congested sections was by reclaiming submerged lands.

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(294) Loprestis, P., *La Bonifica delle valli de Serres e Drama in Macedonia,* Ingegnere, Rome, Italy, Vol. 6, No. 2, pp. 657–660, September 1932.

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(295) Bigorgne, O., *L'aménagement hydraulique d'un grand casier dans le delta tonkinois,* Annales des Ponts et Chaussées, Paris, France, Vol. 108, No. 3.

Describes design and construction of structures for combined drainage and irrigation projects covering 110,000 hectares in the delta of the Red River, Tonkin.

8. ISRAEL

(296) Engineering News-Record, *Israel Drains 15,000 Acres of Jordan River Swampland,* Vol. 157, No. 3, pp. 59–60, July 19, 1956.

Describes drainage of Jordan River swamplands by dredging and drainage canals.

9. ITALY

(297) De Thierry, G., *Die Trockenlegung der Pontinischen Sümpfe; ein Friedenswerk Mussolinis,* VDI Zeitschrift, Berlin, Germany, Vol. 79, No. 6, pp. 183–186, Feb. 10, 1934.

Gives historical and engineering information on reclamation of Pontine marshes.

(298) Flűck, H., *Die 'Bonifica Integrale' Italiens,* Schweizerische Bauzeitung, Zűrich, Switzerland, Vol. 102, Nos. 20 and 21, pp. 237–241 and 253–256, Nov. 11, 1934, and Nov. 18, 1934.

Reviews progress of land reclamation in Italy.

(299) Niemeier, *Neues von der Italienischen Meliorations-Taetigkeit* (Recent Developments in Italian Reclamation Work), Zentralblatt der Bauverwaltung, Vol. 51, Nos. 24 and 27, pp. 347–350 and 409–412, June 17 and July 1, 1931.

Reviews progress in administration and engineering, with special reference to construction of levees and drainage work in Po Valley near Ferrara, reclamation of marshes at Grosseto, and drainage of Pontine swamps.

(300) Scalesse, F., *La Bonifica del Sele* (Reclamation of the Sele area), Annali dei Lavori Pubblici, Rome, Italy, Vol. 74, No. 12, pp. 998–1005, December 1936.

Describes Sele Basin reclamation project, on east coast of Italy, occupying an area of over 14,000 hectares.

(301) Tassinari, Guiseppe, *Ten Years of Integral Land-Reclamation Under the Mussolini Act,* Fratelli Lega, Faenza, Italy, 165 pp., 1939.

A report on land reclamation in Italy, primarily of interest for the illustrations showing drainage work in the Italian marshes.

(302) Wheaton, H. H. *Historic Pontine Marshes Drained,* Civil Engineering, Vol. 4, No. 2, pp. 78–80, February 1934.

Describes drainage of the 187,000-acre area of the Pontine Marshes on the west coast of Italy. The purpose of this project was two-fold: (1) to eliminate the serious malaria menace that has existed for centuries, and (2) to provide work and farms for Italy's war veterans.

10. THE NETHERLANDS

There is an extensive literature dealing with the reclamation of parts of the former Zuider Zee, both general and technical. Many of the technical articles have appeared in the periodical entitled *De Ingenieur,* The Hague, The Netherlands. Other useful technical articles have been published in *Polytechnisch Tijdschrift,* Haarlem, The Netherlands, and in a third Dutch periodical, *Weg en Waterbouw.* A good general introduction to the early phases of the work is:

(303) Jansma, K., *Drainage of the Zuider Zee,* Geographical Review, Vol. 21, No. 4, pp. 574–583, October 1931.

During the early thirties a considerable number of other articles of a general nature appeared in the professional press; the following are a selection:

(304) Blocq van Kuffeler, V. J. P. de, *Der Gegenwaertige Stand der Zuidersee-Arbeiten,* Werft-Reederei-Hafen, Berlin, Germany, Vol. 42, No. 12, pp. 221–224, June 6, 1931.

(305) Blocq van Kuffeler, V. J. P. de, *L'endiguement du Zuyderzee,* Société des Ingenieurs Civils de France, Mémoires et Compte Rendu des Travaux, Bulletin, Paris, France, Vol. 86, Nos. 7–8, pp. 819–861, July–August 1933.

(306) Cunningham, B., *The Enclosure and Partial Reclamation of The Zuider Zee,* Water and Water Engineering, London, England, Vol. 32, No. 373, pp. 5–7, Jan. 20, 1930.

(307) Cunningham, B., *Enclosure of Zuider Zee,* Engineering, London, England, Vol. 134, pp. 553–554, Nov. 11, 1932.

(308) Dedel, D. A., *Enclosure and Partial Reclamation of Zuider Zee,* Engineering and Contracting, Vol. 70, No. 5, pp. 107–113, May 1931.

(309) Fournier, L., *L'assèchement du Zuiderzée,* Nature, Paris, France, No. 2852, pp. 195–201, Mar. 1, 1931.

(310) Haile, W. H., *Land Drainage in England and Holland,* Institution of Municipal and County Engineers Journal, London, England, Vol. 60, No. 14, pp. 1024–1035, Jan. 2, 1934.

Describes several modern drainage projects in Great Britain and features of Zuider Zee reclamation in the Netherlands.

(311) Herz, O. J., *Abschluss und teilweise Trockenlegung der Zuiderzee,* Wasserwirtschaft und Technik, Vienna, Austria, Vol. 3, Nos. 10–11–12, pp. 104–107, 117–120, Apr. 5, 1936 and Apr. 20, 1936.

(312) Herz, O. J., *Ausfuehrung der Arbeiten zum Abschluss und zur teilweisen Trockenlegung der Zuiderzee in Holland,* Wasserwirtschaft und Technik, Vienna, Austria, Vol. 29, Nos. 26–27, 31–32, pp. 260–265, 352–357, Sept. 15, 1936 and Nov. 5, 1936.

(313) Herz, O. J., *Die Trockenlegung der Zuiderzee,* Wasserwirtschaft und Technik, Vienna, Austria, Vol. 4, Nos. 5–6, pp. 51–60, Feb. 28, 1937.

(314) Kamp, W., *Reclamation of Zuider Zee,* Civil Engineering, London, England, Vol. 33, No. 383, pp. 176–179, May 1938.

(315) Powers, W. L., *The Zuider Zee Reclamation Project,* Agricultural Engineering, St. Joseph, Michigan, Vol. 11, No. 12, pp. 395–396, Dec. 1930.

(316) Schmidt, R., *Zur Frage der Landgewinnung an der Nordseekueste,* Zentralblatt der Bauverwaltung, Berlin, Germany, Vol. 54, No. 14, pp. 173–178, Apr. 4, 1934.

Reviews achievement of land reclamation in Zuider Zee region of the Netherlands and discusses similar projects for land reclamation on North Sea coast of Germany, south of Danish border.

(317) Schmidt, R., *Fortsetzung der Landgewinnungsarbeiten in der Zuiderzee,* Zentralblatt der Bauverwaltung, Berlin, Germany, Vol. 56, No. 47, pp. 1319–1321, Nov. 18, 1936.

(318) Shaw, A. L., *Reclamation of Zuiderzee,* Engineering-News-Record, Vol. 109, No. 22, pp. 639–643, Dec. 1, 1932.

(319) Van Rinsum, A., *Der Abschluss und die teilweise Trockenlegung der Zuiderzee,* Bautechnik, Berlin, Germany, Vol. 9, Nos. 37, 39, 43, pp. 539–543, 563–567, 637–641, Aug. 28, 1931, Sept. 11, 1931, Oct. 2, 1931: Vol. 10, No. 34, pp. 437–440, Aug. 5, 1932.

(320) Young, G. R., *Reclamation of Zuiderzee,* Military Engineer, Vol. 24, No. 133, pp. 15–19, January–February 1932.

(321) Génie Civil, *Les Travaux de fermeture et d'assèchement du Zuiderzée,* Paris, France, Vol. 101, No. 27, pp. 656–657, December 31, 1932; Vol. 103, No. 11, pp. 245–249, Sept. 9, 1933.

Among the more recent general publications, the following may be of interest:

(322) Blocq van Kuffeler, V. J. P. de, *De Ontwikkelingsgang bij de Zuiderzeewerken,* Berichten van de Nederlandse Vereeniging voor Landaanwinning, The Hague, No. 1, pp. 7–63, 1950.

(323) Glikson, A., *The North East Polder,* Regional Planning and Development, Leiden, pp. 105–111, 1955.

(324) Veen, J. van, *Dredge, Drain, Reclaim; The Art of a Nation,* M. Nijhof, The Hague, 179 pp., 1950.

(325) Veen, J. van, *Land Below Sea Level,* Staatsdrukkerij, The Hague, 32 pp., 1953.

(326) Wartena, Johannes, *The Enclosure and Reclamation of the Dutch Zuider Zee,* The Engineering Journal, Vol. 33, No. 4, pp. 276–278, April 1950.

(327) Travaux, *Les Travaux du Zuyderzée, Exécution des digues du Polder Nord-Est,* Paris, France, Vol. 23, No. 75, pp. 107–111, March 1939.

(328) Engineering News-Record, *Reclamation of Zuider Zee,* Vol. 144, No. 14, pp. 49–50, Apr. 6, 1940.

(329) Directie van de Wieringermeer (Noordoostpolderwerken), *Excursiegids voor de Noordoostpolder in Oostelijk Flevoland* (Excursion Guide for Northeast Polder and East Flevoland), Zwolle, The Netherlands, 141 pp., 1956.

Among the more technical publications are the following:

(330) Blocq van Kuffeler, V. J. P. de, *De Beteugelingsdammen in de Afsluitdijk van de Zuiderzee* (The Control Dams in the Enclosure Dike of the Zuiderzee), De Ingenieur, The Hague, Vol. 45, No. 50, pp. B 313–326, Dec. 12, 1930.

(331) Blocq van Kuffeler, V. J. P. de, Thijsse, J. T. de, Telders, J. H., *De Afsluiting van de Zuiderzee,* Symposium, De Ingenieur, The Hague, Vol. 48, No. 18, pp. B 58–86, May 5, 1933.

A symposium of three papers: *General Discussion on Construction of Dike Structure; Water Turbulence;* and *Carrying out of Zuider Zee Works.*

(332) Bosch, van Rosenthal, E. J., *Een Onderzoek naar de Economie van Ontwateringswerken* (An Investigation into the Economics of Drainage), De Ingenieur, The Hague, Vol. 53, Nos. 11, 12, and 14, pp. T 9–19, T 21–30, T 31–43, March 18, 1938, March 25, 1938, April 15, 1938.

Study of costs of drainage projects. Provides analysis of costs for works carried out in the Netherlands at various periods under different conditions.

(333) Caissonnummer, *Weg-en Waterbouw,* 1954.

(334) deBooy, J., Jr., *Werkwijze voor het Afdammen van Stroomend of aan Getijbeweging Onderhevig Water* (A Mode of Operation for Closing off Flowing Water or Water Subject to Tidal Currents by Means of a Dam), De Ingenieur, The Hague, Vol. 45, Nos. 33 and 37, pp. B 199–205 and B 249–250, August 15, 1930 and September 12, 1930.

(335) Groen, P., *Storm en Stuwing* (Storms and Storm Surges), De Ingenieur, The Hague, Vol. 65, No. 31, pp. A 341–346, July 31, 1953.

(336) Geers, F. J. B. G., *De Dijken van Oostelijk-Flevoland* (The Dikes of East-Flevoland), De Ingenieur, The Hague, Vol. 66, No. 27, pp. B 108–118, July 2, 1954.

(337) Nobel, J. C. le, *Het Ontwerp van de Gemalen van Oostelijk-Flevoland (Zuiderzeewerken),* (Project for Pumping Works of East Flevoland), De Ingenieur, The Hague, Vol. 66, No. 26, pp. B 89–100, June 25, 1954.

(338) Nobel, J. C. le, *Het Ontwerp van de Toegangssluizen van Oostelijk-Flevoland (Zuiderzeewerken),* (Ship locks for East Flevoland), De Ingenieur, The Hague, Vol. 66, No. 27, pp. B 101–108, July 2, 1954.

(339) Postma, K. R., *Storm en Stormvloedprognose* (Storm and Storm Tide Prognosis), De Ingenieur, The Hague, Vol. 65, No. 32, pp. A 357–363, August 7, 1953.

(340) Thijsse, J. T., *Influence of Closing of Zuider Zee on Tidal Regimen along Dutch Coast,* Permanent International Association of Navigation Congresses Bulletin, Brussels, Belgium, Vol. 8, No. 15, pp. 59–82, January 1933.

(341) Volker, A., *Het Randmeer langs de Veluwe* (The Marginal Lake along the Veluwe), De Ingenieur, The Hague, Vol. 66, No. 48, pp. B 173–184, Nov. 26, 1954.

(342) Wall, J. F. R. van de, *De Osterpolder als Onderdeel van de Inpolderingen in de Zuidelijke Kom van het IJsselmeer* (The East Polder as Part of the Reclamation of the Southern Portion of the IJsselmeer), De Ingenieur, The Hague, Vol. 66, No. 48, pp. B 167–172, Nov. 26, 1954.

(343) Wemelsfelder, P. J., *De Overstromingsramp 1953. Waterstanden,* De Ingenieur, The Hague, Vol. 65, No. 33, pp. A 371–377, Aug. 14, 1953.

On new reclamation plans in the southwestern part of the Netherlands, and on reclamation of the Lauwerszee, see:

(344) Stuvel, H. J., *Het Deltaplan,* Scheltema en Holkema, Amsterdam, 362 pp., 1956.

(345) Verhoeven, A. G., *Development and Reclamation of Biesbosch District in South Holland,* De Ingenieur, The Hague, Vol. 44, No. 49, pp. B 283–298, Dec. 7, 1929.

On problems of salinity see, among others, the following:

(346) *Verslag der Commissie tot Onderzoek naar de Verzouting der Boezemwateren van Delfland,* Delft, 1922.

(347) Rijksuitgeverij, *Ontzilting van Noordholland,* Rapport van de Commissie inzake het Zoutgehalte der Boezen-en Polderwateren van Noordholland, ingesteld bij Besluit van de Minister van Waterstaat van 24 April 1939, The Hague, 191 pp., 1946.

(348) Veen, J. van, *De Toeneming van het Zoutgehalte op de Benedenrivieren,* Tijdschrift van het Kon. Ned. Aardrijkskundig Genootschap, Leiden, Vol. 58, No. 1, pp. 5–37, January 1941.

(349) Commissie voor Hydrologisch Onderzoek, TNO, *Verslagen Technische Bijeenkomsten,* Staatsdrukkerij, The Hague, Nos. 1–6, 330 pp., 1952.

(350) *Interim-Adviezen Delta Commissie*
Interim-advies (1): *Verhoging Schouwensedijk,* Staatsdrukkerij, The Hague, 8 pp., 1953.
Interim-advies (2): *Afsluiting Hollandse IJssel,* Staatsdrukkerij, The Hague, 4 pp., 1953.
Interim-advies (3): *Afdamming Zeearmen,* Staatsdrukkerij, The Hague, 28 pp., 1954.
Interim-advies (4): *Afdamming Veeregat en Zandkreek (Drie-Eilanden Plan)*, Staatsdrukkerij, The Hague, 6 pp., 1955.
Interim-advies (5): *Nadere Beschouwingen in Verband met de Afdamming van de Zeearmen,* Staatsdrukkerij, The Hague, 45 pp., 1955.

(351) Kamerstukken Tweede Kamer der Staten-Generaal III 4167, *Memorie van Toelichting, Ontwerp Deltawet*, No. 4167, pp. 3–27, Zitting 1955–1956.

(352) *Deltaplan, Afdamming Zeearmen.* Drie prae-adviezen van Nederlandsche Maatschappij voor Nijverheid en Handel, 82 pp., 1954.
1. Ir. A. G. Maris, *Het Waterstaatkundig Aspect van het Deltaplan,* pp. 3–28.
2. Prof. Dr. J. Tinbergen, *Economisch Aspect van het Deltaplan*, pp. 29–53.
3. Prof. G. H. L. Zeegers, *Het Planologisch en Sociologisch Aspect van het Deltaplan,* pp. 55–82.

Further pertinent information can be obtained from the "Department van Verkeer en Waterstaat" of the Netherlands, Directie van de Waterstaat, The Hague, The Netherlands, and from the International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands.

11. NEW ZEALAND

(353) Williams, C. J. R., *The Developments of Lyttelton Harbor, New Zealand*, Institution of Civil Engineers, Advance Paper No. 4694, 26 pp., 1930.
Gives history of port of Lyttelton and recent construction, dredging and reclamation.

12. PANAMA

(354) Mittag, A. A., *Albrook Flying Field in Canal Zone*, Civil Engineering, Vol. 4, No. 7, pp. 340–344, July 1934.
Describes military airport at Balboa, Panama Canal, and dredging excavation for raising airport ground.

13. SINGAPORE

(355) Friend, J. F., *Building Airport in Singapore,* Excavating Engineer, Vol. 30, No. 7, pp. 345–347, and 376, July 1936.

(356) Nunn, R. L., *Singapore Airport,* Institution of Civil Engineers Journal, London, England, Vol. 12, Nos. 7 and 8, pp. 69–91, 92–104 and 530–534, June and October 1939.
Reports on design and construction of new airport, selection of site, and reclamation methods and costs.

14. UNION OF SOUTH AFRICA

(357) Engineering, *Cape Town's City and Harbor Scheme,* London, England, Vol. 164, No. 4266, pp. 410–411, Oct. 15, 1937.
Gives brief description of scheme to reclaim portion of foreshore of Table Bay lying between metropolitan area and New Basin.

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